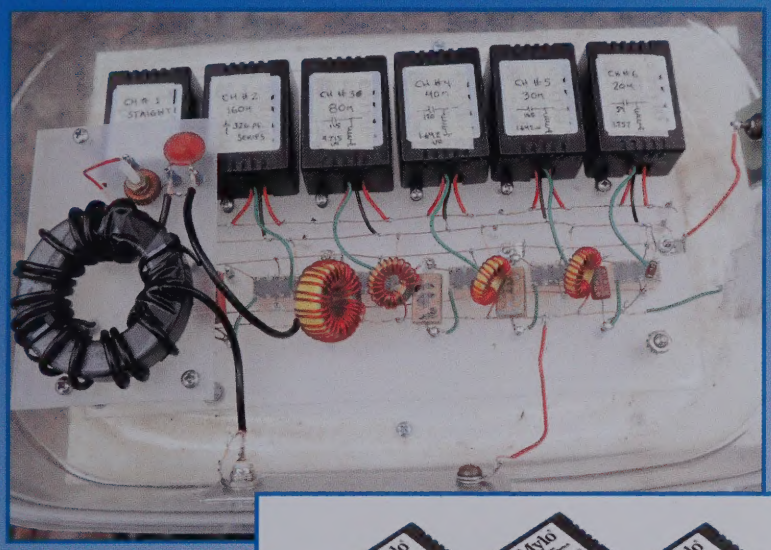
YOUR CONSTRUCTION AND OPERATING QRP SOURCEBOOK

QRP Quarterly

Volume 62 Number 1
January 2021

Journal of the QRP Amateur Radio Club International



KI4IO Uses Wireless Switch Modules for a Remote Antenna Tuner

- *ND6T Has Some Handy Workbench Gadgets*
- *KV4QB Describes His Arduino Based 63 dB RF Step Attenuator*
- *Let's Go Pedestrian Mobile with WØRW*
- *WK8S Reviews the RGO One Transceiver*

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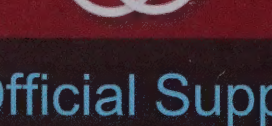

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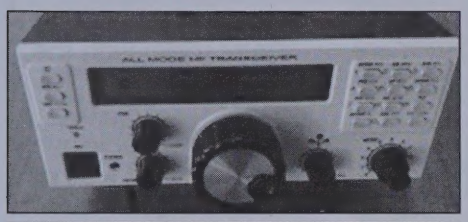

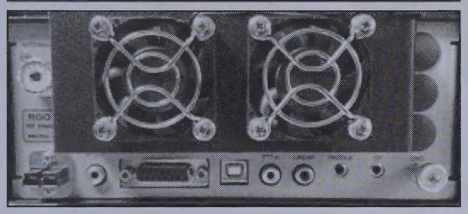

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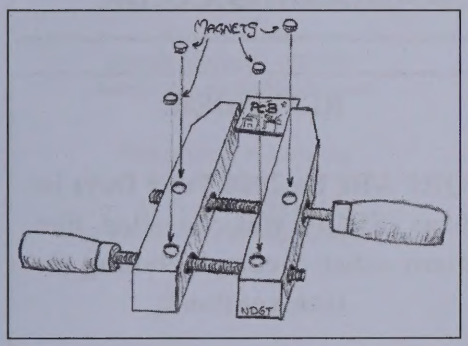

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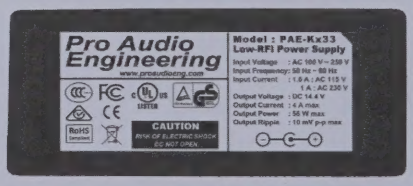

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REMINDER:

QRP ARCI's 2020 Four Days in May (FDIM) was cancelled, like many other events, including the Hamvention®.

Plans are underway for the next FDIM, whether in-person or virtual (or both), with the usual lineup of excellent speakers and QRP activities!

Some of the presentations scheduled for 2020 are apearing as articles in *QRP Quarterly*, so you're not missing them!

In the mean time...
Keep yourself safe and well.

www.qrparci.org/fdim/

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Letter from the Editor

Mike Malone—KD5KXF editor@qrparci.org

The holiday season has a way of enveloping me with too many things to do and not enough time to get them done. Still, time is found for reminiscing about events, people, and situations past. It is actually easy to wonder if that is not what the story "A Christmas Carol" is really about. For me, no winter season is complete without memories of shortwave and AM radio DXing. Later years, when at driving age, there are memories of radios that could transmit, and the misadventures of antenna wrangling.

One little trip down memory lane comes courtesy of the HallicraftersCompany. The particular model was the S-38D. When current Mike looks at one of these now, it seems to have shrunk in both size and complexity. Pre-pubescent Mike remembers the gleaming gun metal gray paint, that genuine glass dial cover, and all of those markings on what looked like the metal out of my great grandparent's freezer. Cities from all over the world listed, exotic controls like bandspread, and all of those bands. Just the weird noises you got when tuning threw you into a mindset of being in a Science Fiction drama.

That radio and I spent a lot of time together. That was a real radio, it had lights, glowing tubes, and would shock the bejabbers out of you if you weren't careful. It also opened up the knowledge of bands and propagation to this young mind. My gosh, the thing even made its own smells! Some of those smells were useful for troubleshooting too. Those are all just the trimmings of the memories that this time of year brings, the real meat was listening to hams sending CW. That radio spurred me on to another dust burning, smelly old radio… a Heathkit HW-16. Fittingly, it was received for Christmas when I was 16 years old. That whole process propelled me into a lifelong interest in radio.

Some of those dust burning tube radios take me back to my childhood bedroom in Irving, Texas. A soft Christmas Carol playing with occasional atmospheric accompaniment, my windows lit up by the big C7 Christmas lights on the exterior of the house… and me… just in between sleep and awake, waiting for the station to give their ID. Remember, this was the seventies, so to find out just where that station was, you sometimes had to go to the library and check in the book. There are lots of other fond memories that rattle around in my head, but these are some of my favorites. Those radios may be gone now, but I like to think that the signals I sent with the ones that transmitted are still travelling in space, looking for a similar era receiver to complete the journey.

Here's hoping the Holidays were Happy for you and yours!

72 de KD5KXF
Mike Malone
Editor, QRP Quarterly

From the President

David Cripe—NMØS president@qrparci.org

Greetings to all!

As I write this, 2020 winds down to its eagerly anticipated ending, and we look forward to an uncertain 2021. The question in everyone's mind is what will happen to FDIM?

So much of the success of FDIM hinges on the Dayton Hamvention, and at the moment, the Hamvention is planned to take place. At this time, however, the Fairborn Holiday Inn is limiting occupancy of the ballroom in which we meet. This would dramatically change the shape of our event, and our planning has to be dependent on the restrictions placed upon us. As the scope of the COVID pandemic shifts, it is challenging to attempt to anticipate what conditions will be in May and what restrictions may be placed on a physical FDIM. Consequently, we will have to wait until February before we can make a final decision about the details of FDIM. These will be announced on the QRP ARCI e-mail reflector and website as soon as plans are final. We thank everyone for their patience.

In the meantime, we observe other ham radio organizations enjoying success with virtual, on-line events. Given that many of our usual attendees may be reluctant to travel during these times, the decision has been made that FDIM will include a virtual, on-line streaming of the Thursday presentations, so that those unable to be present may still enjoy the event. Details of this will be announced when they are finalized, also.

While the QRP ARCI Board of Directors and volunteers labor to pull our FDIM plans together, we are enjoying some sunspots! Cycle 25 is waking up, and we're starting to see some good propagation again! Enjoy these conditions, and keep on QRPing!

73, Dave Cripe NMØS
President, QRP ARCI

●●

QRP ARCI News

QRP QRCI Mail List

A new Mail List was recently started for QRP ARCI on the groups.io platform. This mail list is open to members and non-members alike for the discussion of QRP ARCI topics. Jim Stafford W4QO is the moderator of the list and you can gain access by sending an email to qrparci+subscribe@groups.io and requesting to be added to the mail list. You can get your mail in digest form as well if you prefer it that way.

How to Volunteer with QRP ARCI

Do You Want to Help Guide QRP ARCI as an Officer or Manager?

From time-to-time QRP ARCI officer positions are up for election, and current officers may resign for various reasons. It is extremely useful to the officers and Board of Directors to know which QRPers are willing and interested in a leadership position. Although the significant work required of an officer is personally rewarding, it usually means that nominations for election must be actively recruited. Let the present leadership know you are interested!

Similarly, the appointed manager positions for the Toy Store, Contests, Awards, Webmaster, and Editor of *QRP Quarterly* may become open from time-to-time, requiring a willing volunteer to step forward and give support to the club's operation. You can contact any officer or Board member to let them know you are willing to help.

All volunteer organizations rely on the talents, willing effort, and supportive participation of its members! QRP ARCI members include hams with a wide range of skills and experience. Sharing those things with your fellow QRPers—whether for one term or a long tenure—will help keep the club strong!

QRP-ARCI Thanks you!

www.qrparci.org

The club web site is the center of QRP information. Check your subscriber status, join or renew online, and be sure to check all the other club services that are offered. Links to other QRP resources are a valuable part of the information available!

G-QRP Club News

Steve Hartley, GØFUW, Chairman
g0fuw@gqrp.co.uk

2020 will be remembered as a very strange year for all sorts of reasons but in amongst the chaos of enforced lockdown there were some exciting developments, which may not have happened under normal circumstances. Two of those were the G-QRP Club Convention and the inaugural G3RJV Memorial Construction Competition.

The G-QRP Club has around 4000 members, predominantly in the UK, but many others are spread across the globe. The Club has been hosting Conventions every year since 1989, initially in George's church hall, and church, in Rochdale. Later the Convention moved to Rishworth School and in 2018 it moved to be co-located with the Telford Hamfest.

Inevitably, the Covid restrictions forced the cancellation of many physical meetings, including the Telford bash. Having seen the great work that the Denby Dale Club had done to put on virtual meetings we consulted the G-QRP Club membership to see if there was support for an on-line Convention, and if anyone would be willing to help make it happen. The answer to both questions

was a resounding 'yes!'.

Before we knew it we had two-days of talks and knowledge sharing sessions planned with speakers from the UK, France, Turkey, Canada and the USA. We also had hosts and co-hosts from both sides of the pond. We had hoped to include a virtual Buildathon but the logistics, the prospect of remote fault finding and the supply of lost/damaged parts, pushed it into the 'all too difficult' category.

We sold tickets to attend the Convention, just to cover the costs of the professional Zoom licences required and when ticket sales exceeded the 500 set limit we had to buy more 'seating capacity'. In the end we had nearly 13% of the membership in attendance, which was way beyond our expectation. It was equally amazing to see all three IARU Regions represented in the audience, with some staying up all night and others waking at daft o'clock to tune in.

The talks covered a very wide range of topics from the development of the QRP Labs kits, with Hans, GØUPL, to the joys of scratch building a simple SSB transceiver, with Pete, N6QW, and the more hardware engineering side of things with Leslie, GØNMD, explaining how he built his Shack On A Pole. Antenna topics are always popular and we had Callum, MØMCX, from DX Commander, John, G8SEQ talking about omni-directional antennas with gain and John, VE3IPS, shedding some light on the misunderstood T2FD. One of the best attended sessions was Alan, W2AEW, explaining how VNAs work and sharing ways of using a NanoVNA. All in all there were 19 sessions and all are now available for anyone to watch on the G-QRP Club You Tube channel.

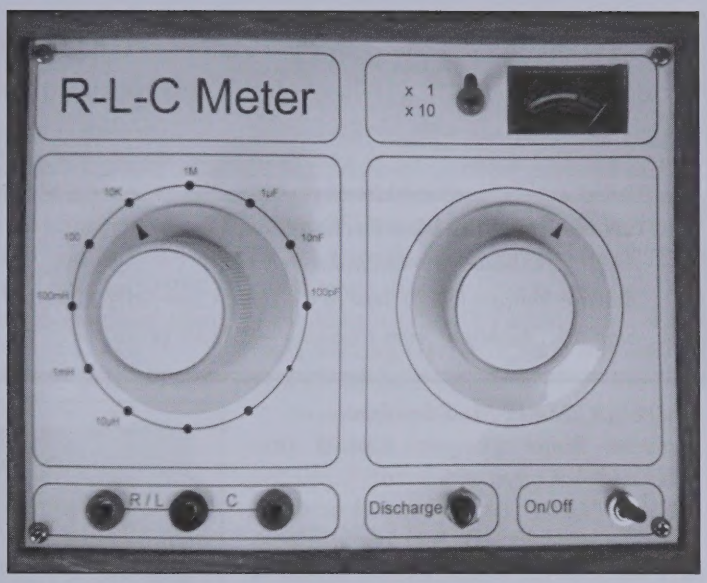
We hope to be able to return to a physical Convention in 2021 but we plan to run it on-line in parallel with the 'live' event to maintain the access for our overseas members, overseas speakers and those who are unable to travel within the UK.

The second Club event that looked doomed to fall foul of lockdown was the first ever construction competition for the George Dobbs, G3RJV, memorial trophy. The competition judging had been planned to take place at Telford so we clearly had to think again. The success of the virtual Convention spurred us on to think about how we could judge remotely. In the end, members sent written details and/or web links for their projects and those who were shortlisted were invited to present their work, and answer questions, in a short Zoom session with the Club Committee.

First up was an LCR Bridge by Cor, PA3COR. The design originated in a *Practical Wireless* article from the 1960s. Cor's construction exhibited much 'kitchen table technology' with good use of junk box parts and a tea bag storage box. Calibration was achieved using some precision parts of known value.

Next was Tony, G4WIF, with his Arduino-based WSPR beacon. Tony had based his project on the work of Tony, F4GOH, to produce a very compact waterproof beacon. The construction included a mix of matrix board and breakout boards with a plug-in PA module to aid replacement of blown transistors. For more information, see Tony's website:http://www.fishpool.org.uk/wspr.htm

Kevin, MØKHZ, also produced a WSPR beacon, but his was designed from the ground up using a Teensy micro-computer and



LCR Bridge by Cor van Rij, PA3COR, winner of the G3RJV Memorial Construction Competition.

bespoke PCBs all housed in a robust Hammond enclosure. Richard outlined how modern CAD allows easy PCB design and ordering of small quantities of PCBs from the far East. Richard's design and PCB files are all available on Github.

Finally, Colin, G8TMV, showed us his surface mount version of the old Rockmite transceiver, the Quartzmite. Colin had discussed his plans with Dave Benson, the designer of the original rig, and had added some improvements to produce a very compact transceiver that fits in a small mint tin, has reasonable QRP performance and includes a keyer; this was clearly no cheap Pixie! You can see more information on Colin's website:https://www.tuckley.org/qmite/

The Committee had a very difficult job in selecting a winner; all four projects were excellent in their own way and any one of them would have been a worthy winner; all four builders had shown some ingenuity and construction craft and all four projects were repeatable. In the end, the Committee members were unanimous in thinking that if George were judging, the LCR Bridge would be his choice, so Cor, PA3COR, was awarded the very first G3RJV Trophy. The G8TMV Quartzmite came in as Runner Up and the other two were awarded Highly Commended certificates, but it was a very close run thing.

What we learned from these two events was that the use of teleconferencing can allow things to happen that would otherwise have been cancelled and that there are distinct advantages in using such technology. As radio amateurs we should not be surprised by this but our experience of running an on-line convention and construction competition has definitely shifted our perception on what is and isn't possible for the future. The notion of a virtual Buildathon has not gone away, it just needs a bit more planning.

The G-QRP Convention 2021 is planned to take place at Telford, and on-line, over a weekend in September. Look out for further announcements but in the meantime, why not check out this year's presentations? Just search for 'G-QRP Club' on YouTube.

Idea Exchange

Technical Tidbits for the QRPer

Mike Czuhajewsi—WA8MCQ wa8mcq@verizon.net

In this edition of the Idea Exchange:

AADE L/C Meter Modifications—K3ASW

Beware Voltage Coefficient of Ceramic Caps—Art Rivard

Stop the Flashlight from Flashing—WA8MCQ

AADE L/C Meter Modifications

From Walter Thomas, K3ASW (ex-WA4KAC)—

For experimenters lucky enough to have and use AADE L/C meters, shown in Figure 1, here are some enhancements that improve its usability. (These were sold by Almost All Digital Electronics but are no longer available after the passing of the owner, Neil Hecht.)

To improve zero reading instability, change capacitor C5 (circled in Figure 2) to a 0.22 uF or greater ceramic; the original value is 0.1 uF. Several reports noted that some, but not all, meters became unstable after some years use (Ref. 1). Experiments to determine the cause were not conclusive (Ref. 2). Meters supplied later than about 2011-2012 may already have this higher value installed. I made this change and it improved the zeroing instability that had appeared in my meter after several years use.

(*WA8MCQ comments:* In 2012 I had the company where I worked at the time order an assembled AADE meter for my bench. We had all sorts of fancy HP LCR analyzers and network analyzers that can measure capacitance, but the AADE is far faster and more convenient to use for non-critical applications. I opened it up and noted that the value of C5 was now 0.22 uF instead of 0.1 uF as it had been for years.)

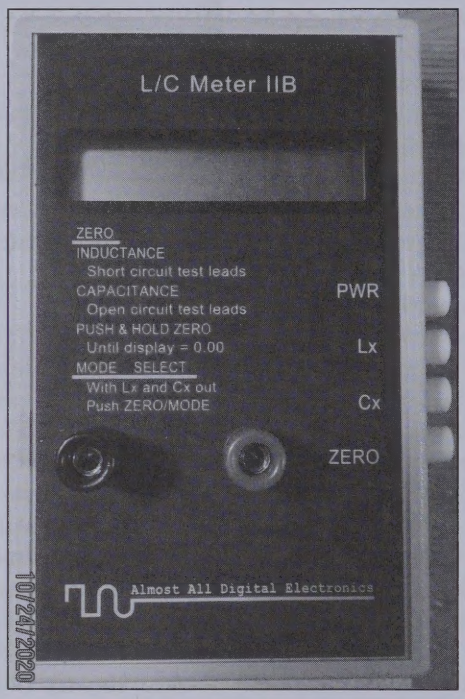


Figure 1—The AADE L/C meter.

However, zeroing for capacitance measurements still presented a problem. Readings would vary from zero by as much as 3 pF after I removed my hand from the momentary zero push button. This likely was caused by hand capacitance effects, since the meter is packaged in a plastic housing. Using a wooden block to hold down the meter while pushing the zero-button with an 8-inch long wooden stick improved the zero reading variability to less than 0.5 to 1 pF, confirming the hand capacitance thesis.

My solution was to remove the cover and affix copper tape which has conductive adhesive (Ref. 3) to the inside top cover from just below the display window to the bottom end of the cover. It was run up the cover walls. It will need to be overlapped to cover the width of the inside cover surface plus the walls. Punch a small hole around the negative (black) terminal mounting screw so that the tape will contact the metal flat around the screw, which is grounded via the printed wiring board's ground plane. It is important to relieve the tape around the positive (red) terminal so it will not be grounded to the copper tape

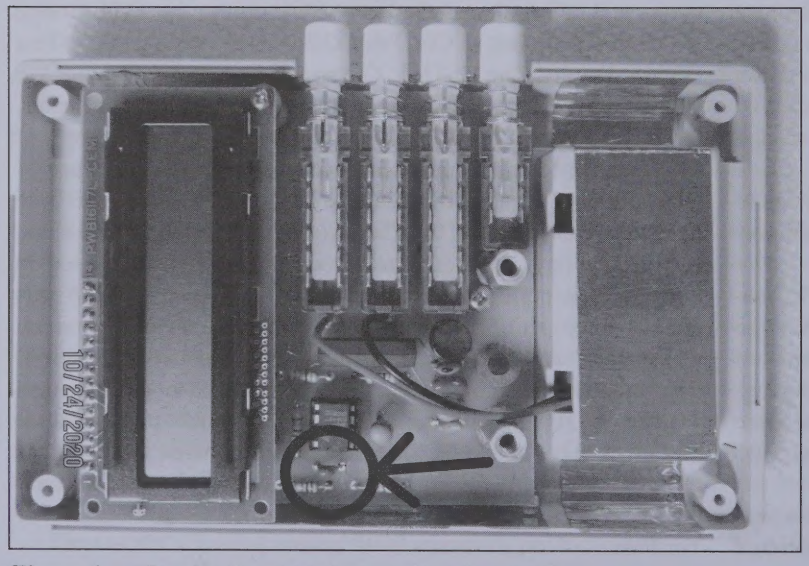


Figure 2—Change the circled capacitor (see text).

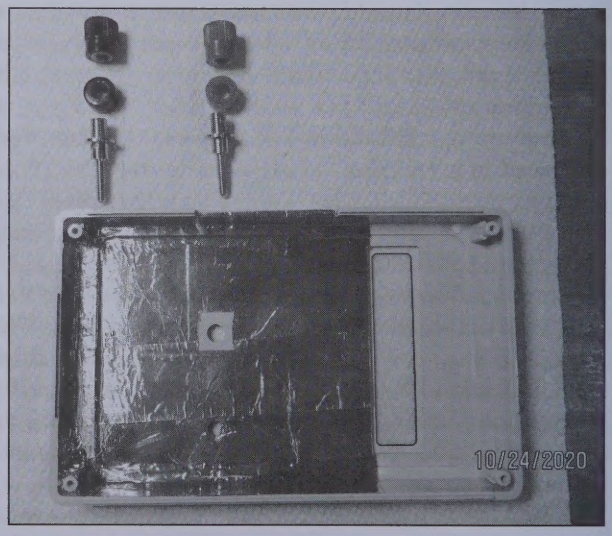


Figure 3—Add copper tape ground plane to front half of case. Also add to rear half, not shown here.

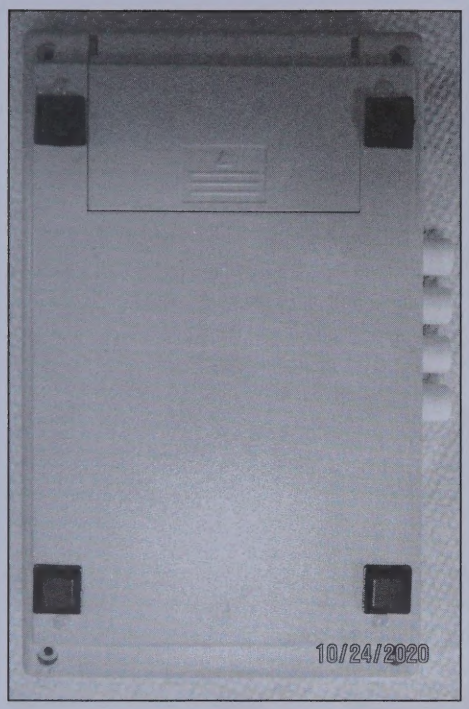


Figure 4—Add stick-on rubber feet to rear of the case.

when the cover is reinstalled.

The copper tape ground plane is shown in Figure 3. I also added tape to the other half of the case, underneath the circuit board. It can be seen in Figure 2 but is mostly hidden. No attempt was made to connect the tape on both halves of the case. I didn't feel it was necessary since things work well as it is. This is just to reduce the hand capacitance effect, not to shield it from external fields.

After making this modification, capacitance zeroing improved to varying at most only 0.01 - 0.02 pF. It now varies less and is quicker. Zeroing the AADE is easier than the Peak/Atlas LCR meter—just a push of the button versus having to go into the Peak meter's menu. The AADE measures low value capacitors with greater resolution, two digits after the decimal point versus only one for the Peak meter.

The other mod I made after I built the meter was to install four stick-on rubber feet (Ref. 4) to the bottom (Figure 4); this keeps it from sliding around on the bench.

References

1. WJ2V, K7QO, WA8MCQ, "Fix for Unstable Readings on the AADE L/C Meter," *QQ* Idea Exchange, Summer/July 2012, pp. 10-11.

2. WA8MCQ, "More Comments on the AADE LC Meter Fix," *QQ* Idea Exchange, Fall/October 2012, pp. 11-12.

3. N2CQR, "Very Useful: Copper Tape with Conductive Adhesive," soldersmoke.blogspot.com/2019/10, posted Wednesday, October 9, 2019. *WA8MCQ note—this tape can be found on amazon.com and is available in 1", 2" and 3" widths.*

4. 3M "Bumpon", part number SJ5007, available from Mouser, Digikey, and other suppliers.

—de K3ASW

Beware Voltage Coefficient of Ceramic Caps

This was posted to the online Heathkit discussion list (heathkit@yahoogroups.com) by Art Rivard, who is not a ham, with the subject line shown above—

A few years ago I encountered a shorted high-voltage ceramic disc capacitor. It was rated 10 nF at 1600V, made in the 1950s, and was slightly over 1-inch diameter. Seeking a suitable replacement, I bought a pack of the same rated parts from China at a price that was hard to resist. Clearly a product of modern technology, they "looked" really good, with straight, even leads and epoxy coating, and they were about half the previous diameter. The capacitance value measured OK, and the leakage at the rated voltage was nil, but still I wondered, how could these be so much smaller? Was it due to the ancient Chinese expertise in pottery? Probably not. I then suspected that they weren't equivalent parts.

Manufacturer specs will show that the size of ceramic caps varies all over the map, depending on capacitance constancy with varying temperature and DC working voltage. The original part, according to published specs, maintained its capacitance value within 10% across the rated temperature and voltage range. No specs were available for my "bargain" replacements, so I tested them myself.

The test circuit was extremely simple, 2 caps in series in an RC highpass filter; the junction was connected to a varying DC voltage through a 10M resistor. I don't recall the other circuit values I used, but the operating conditions had a sine wave signal at a low enough frequency so that the output level was way down the attenuation curve. This way, the output level would vary with capacitance.

I then tested various capacitor formulations for frequency response vs. DC voltage. Film capacitors were perfectly flat, as were mica and NP0 ceramic. GMV ceramic ("guaranteed minimum voltage") was not perfect but still pretty good, X5F was better, Z5U was not so good, but the worst by far were the tiny, bargain caps! Their capacitance value at 0 volts was fine, but went down maybe 10% at 200V, and at the rated working voltage of 1600 was only 5-10% of the rated value!

Now I knew that these caps were basically useless except far below the rated voltage; I doubt that any OEM (original equipment manufacturer) would ever use them. I concluded that such ceramic formulations were known over 60 years ago, but not used in capacitors at that time. If I had installed them, the equipment would not experience a hard failure and perhaps I would have never known of this problem, but I don't work that way.

My takeaway is that one must be cautious when selecting high voltage ceramic capacitors. Be especially cautious if the manufacturer of the parts is unknown. All this should also apply to multi-layer and surface mount devices. The safe option is to buy parts marked by known manufacturers, having detailed specification sheets available, from reputable distributors. My life isn't quite that simple, since I restore vintage equipment. I tend to favor old, NOS (new old stock) and used parts, but I buy them with eyes wide open, and do my own testing. Ceramic capacitors are typically as good as new, regardless of age, in my experience.

As always, caveat emptor.

—de Art Rivard

Stop the Flashlight from Flashing

From WA8MCQ—

I recently bought a pair of small zoom LED flashlights from eBay (Figure 5); they were about $12 for the pair (ref. 1) and have 5 modes, which toggle every time the power is cycled; full brightness, medium, low, continuous flashing and slowly blinking SOS in Morse code. They can cover a wide area or telescope out to zoom in to a small spot. The only mode I would ever want is full brightness so I modified them for that. Note that this modification is not my original idea; I had already seen some online articles about doing it. (Ref. 2

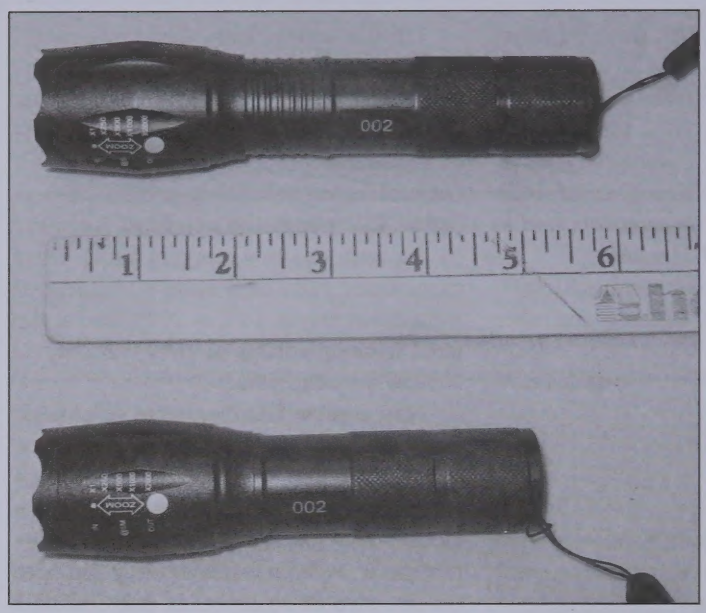


Figure 5—A pair of small zoom flashlights purchased on eBay.

Figure 6—Unscrew the retaining ring.

Figure 7—Unscrew the main unit from the body.

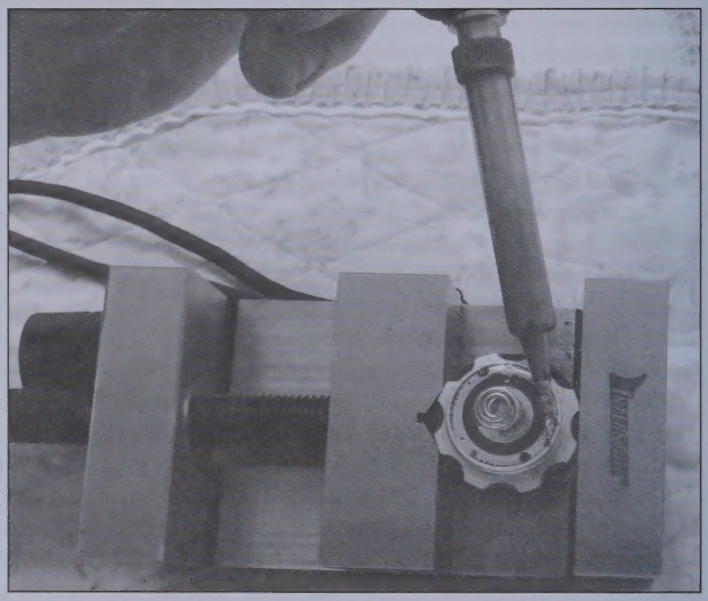


Figure 9—Unsolder the board from the main unit and lift it out.

gives one.)

Zooming is done by pulling the business end away from the body. The longer one in Figure 5 has been zoomed in to a spot and the shorter one is zoomed out to cover a wide area.

Although some of those other lights seen online were from different manufacturers, the basic circuit and board are similar. (The ones I bought use 3 AAA cells, for 4.5 volts, while some use a single AA cell with a circuit to boost the voltage.)

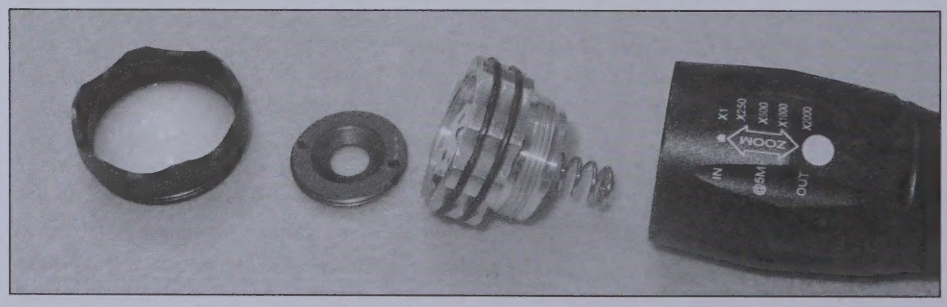


Figure 8—The disassembled flashlight.

The light advances to the next mode every time the power is cycled. If I had been using it at full brightness, the next time I used it I would have to cycle the power several times to get back to that, a definite irritant. It also causes extra wear on the switch. If someone not familiar with it were to pick it up, it could get quite confusing. (If it had been at full brightness, the next time someone turned it on it would be at medium, and cycling again would be in

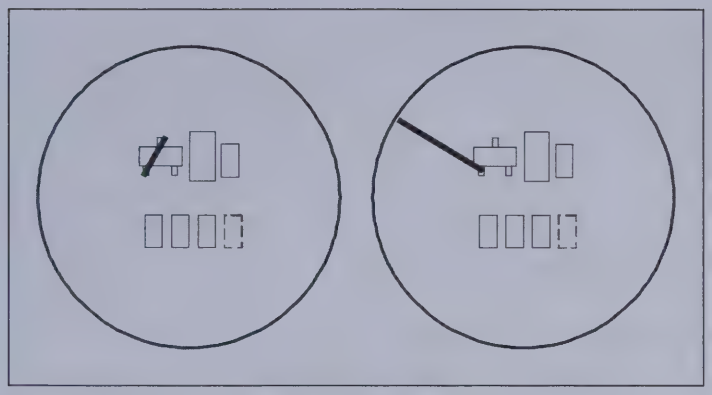


Figure 10—Solder a wire across the terminals or to the outer ground ring.

"dim" mode, which is still somewhat usable, and they may not realize that it has several modes. However, the next time it gets turned on it would come up in flashing mode and now the user would be at a loss.)

Remove the lens assembly by unscrewing it and use a spanner wrench or long nose pliers to remove the brown retaining ring (Figure 6) and then the main unit (Figure 7). Figure 8 shows what you will have at this point. The board is deep inside the cavity and almost impossible to work on. To remove it, turn the unit over, unsolder the board and lift it out (Figure 9). You may want to temporarily remove the LED wires; if so, make a note of which goes where.

The fix is simple. A small surface mount device drives the LED and all you need to do is bypass it. The part itself need not be left in place; it's only necessary to jump around it, by soldering a piece of wire across two specific pads or from one pad to the outer ground ring, indicated in Figure 10. Now, when power is turned on it will come up at full brightness every time.

When done, solder the board back in place and reassemble in reverse order. If the wire to the LED driver was soldered to the outer ground ring it may not allow the board to sit flat but this won't be a problem.

According to the article in ref. 2, the chip is a part number 8133A LED driver. Figure 11 is my redrawing of the schematic in the data sheet.

In case anyone is wondering what's holding the device in Figure 9, it's a toolmakers vise made by Interstate. I bought it on eBay years ago and fortunately it was indeed in perfect condition as claimed. If you want one, that might be the best way to go since the current price for the same one is $221 at MSC, a major industrial supply house. Needless to say, it's a precision device.

References

1. eBay seller batterygallery, "2Pack 90000LM Tactical 5 Modes T6 LED 18650 Flashlight Zoom Torch Aluminum Light". At the time they had sold over 2700, and will probably have these for quite a while.

2. One such article can be found at https://joeraut.com/posts/cree-flashlight-mode-mod/. This particular light, made by Cree, uses a single AA battery with voltage boost circuit.

—de WA8MCQ

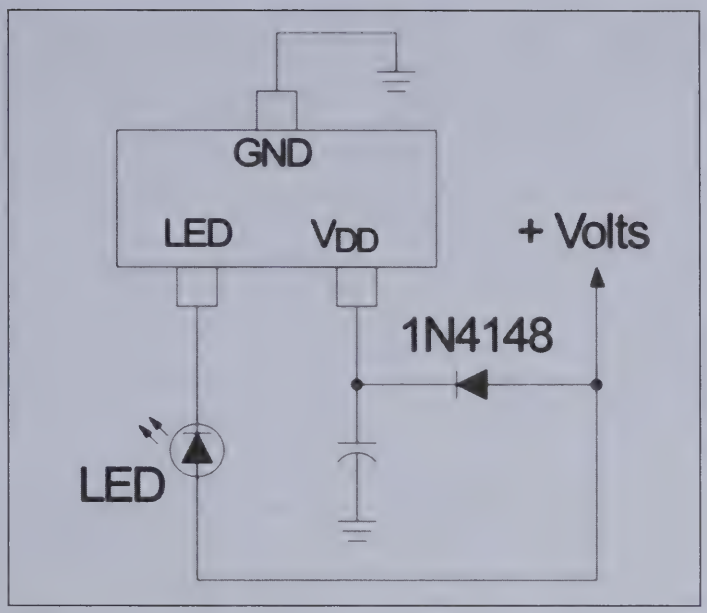


Figure 11—Basic schematic of the LED driver circuit.

The Fine Print

The usual rules apply; send your ideas and projects to me any way you can get it here (e-mail, snail mail, 3 1/2" floppy disk (if I can still find my external drive), CD, handwritten on a napkin, etc), or tell me where you found something good on the Internet. My addresses are 7945 Citadel Drive, Severn, MD 21144, and wa8mcq@verizon.net.

If you have something of interest and aren't sure just where it should go in the *QRP Quarterly*, send it to whichever member of the editorial staff you think is best, and they'll pass it along to someone else as appropriate.

Important note—when you send me something, you must get an acknowledgement from me. If you don't get one, either it never got here or I overlooked it. (Although very rare, both have happened.)

Well written, Pulitzer Prize quality articles are nice, as are computer drawn schematics, but don't worry if you can't do all that. We'll take care of the rest, editing, redrawing, etc. The readers are waiting!

QRP Operating Tips...

There are many times when we operate in the "normal" part of a band instead of near the QRP calling frequencies. Perhaps we're calling a DX station, participating in a contest, or just tuning around the band.

Try to figure out if it is wise to identify as "/QRP" — some hams enjoy working QRP stations, since it means they are hearing well! Others are less impressed and don't like the longer transmission. Contests and DX QSOs will almost always work better with short, snappy calls.

One more thing: send at the same CW speed as the station you are calling. He/she will copy you most easily "in rhythm" at a speed they think is comfortable.

Making a Balanced Antenna Coupler

Jerry Wolczanski—KI4IO jerrywolczanski@earthlink.net

I was slated to speak at FDIM 2020 on the topic of "Making an Antenna Coupler". I intend to give that talk at FDIM 2021 if the world gets back to normal, or the new version of normal! That presentation revolved around the commonly used unbalanced antenna coupler with a BALUN for use with a balanced transmission line, such as open-wire or window line.

This paper deals with the construction of a true balanced tuner such as the Johnson Matchbox or the Palstar BT1500. While these two examples have differing designs, both are electrically symmetrical and designed to drive balanced loads.

The coupler I will discuss is more akin to the Palstar but does not use expensive roller inductors.

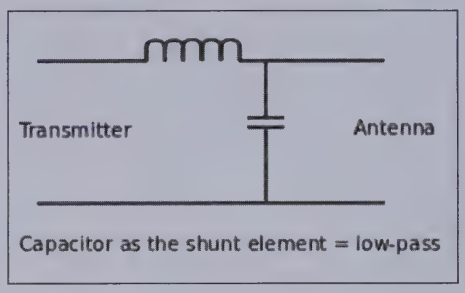


Figure 1—Low-pass configuration.

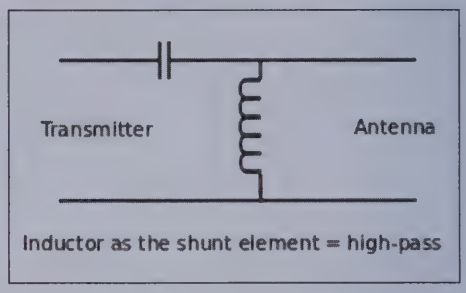


Figure 2—High-pass configuration.

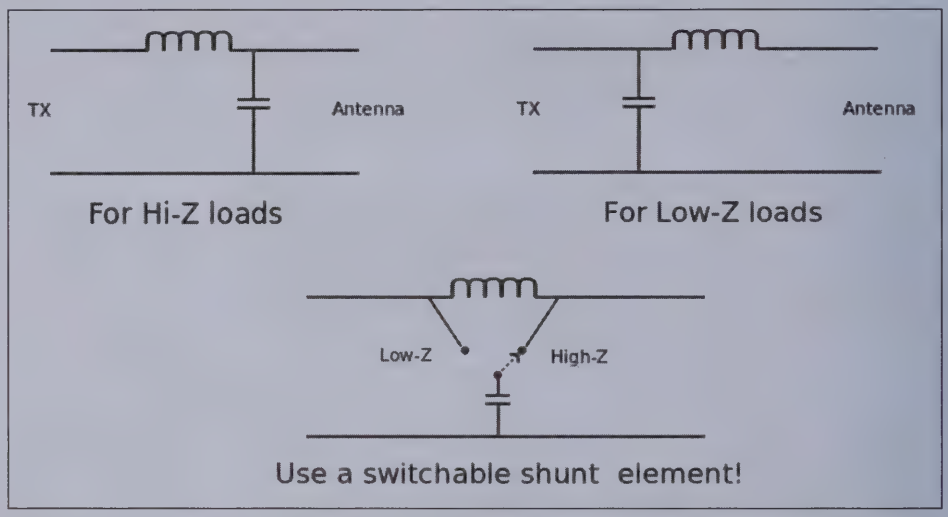


Figure 3—Reversing the transformation from higher or lower impedances can be done with a simple switching arrangement.

High Pass or Low-Pass?

Some antenna couplers employ circuits that have a low-pass configuration. If, for example, the coupler was tuning an antenna on 7 MHz, a low-pass design would offer some attenuation to RF energy above 7 MHz. Some years ago, when TVI was an issue with a lot of amateurs, that amount of attenuation may have meant keeping peace in the neighborhood. These days, modern transmitters and transceivers have good filtering, plus cable TV has all but made TVI a historical footnote.

In my case, however, I live a mere 3,000 meters from a daytime 22 kW AM BC station. Having an antenna coupler design which offers some attenuation to RF energy below my operating frequency is a good thing. See Figures 1 and 2.

So, which architecture the builder selects is left up to the builder. In my case, protection from AM band interference was paramount, so I selected the high-pass L-network, with the inductor as the shunt element.

High-Z or Low-Z?

My main antenna is a 40-meter dipole fed with about 55'- 60' of 4"-spaced home-brew open-wire line. David Ryeburn (VE7EZM) calculated the impedances I would encounter at the tuner end of the feed-line (Table 1).

I would not attempt operation on 160 meters with this antenna, but I use it with great success on 80 meters as well as 40 - 10 meters. My flat-top is 67', but pretty much any length of flat-top will do. The impedance at the tuner depends on the length of the antenna legs plus the impedance transformation through the feed-line length. Some hams, in an attempt to present a suitable impedance to their tuner, switch in/out various lengths of feedline. That has not been necessary in my case, mostly because my home-brew

1.83 MHz	1.14 - j473.79	8.235 dB loss in open wire line
3.8 MHz	6.26 + j228.94	2.221 dB loss in open wire line
7.1 MHz	114.79 - j511.03	0.105 dB loss in open wire line
10.1 MHz	108.2 + j1690	0.836 dB loss in open wire line
14.1 MHz	72.08 + j163.00	0.186 dB loss in open wire line
18.1 MHz	170.11 - j702.88	0.190 dB loss in open wire line
21.1 MHz	208.06 + j620.44	0.165 dB loss in open wire line
24.9 MHz	140.11 + j77.45	0.113 dB loss in open wire line
28.4 MHz	432.00 - j937.70	0.144 dB loss in open wire line

*While maybe representative of open-wire systems in general, my recently acquired nanoVNA has shown these numbers to be somewhat different from the impedances seen in my antenna system.

Table 1—Calculated impedances of the KI4IO antenna system, at the shack end of the balanced feedline.

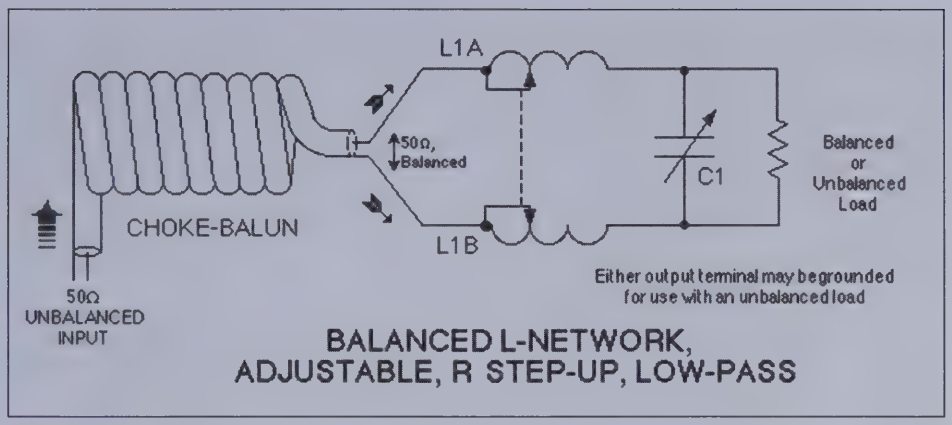


Figure 4—Diagram of AG6K's balanced tuner design.

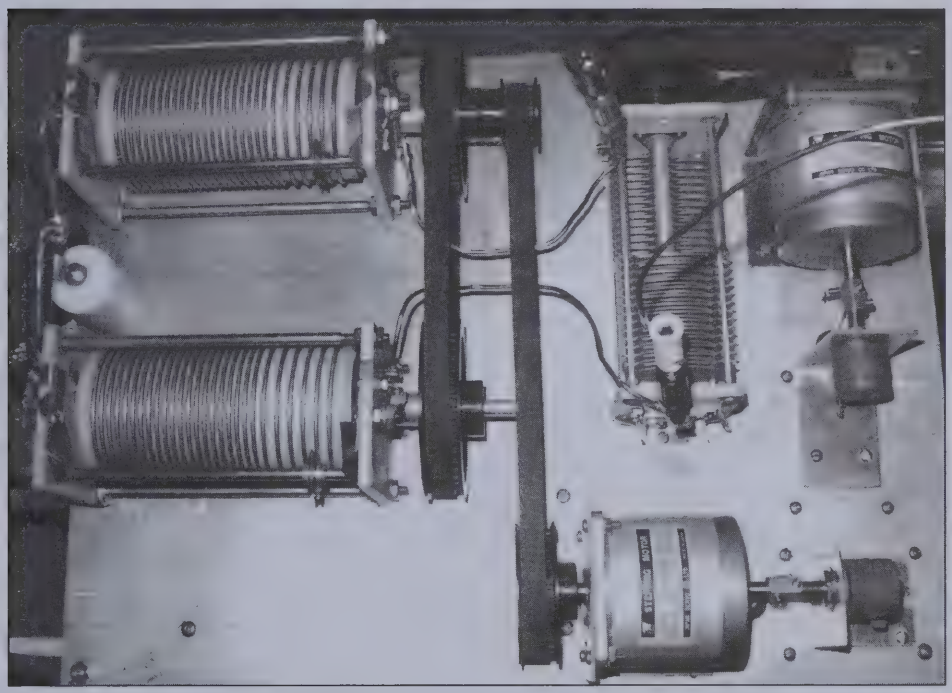


Figure 5—Photo of the AG6K tuner.

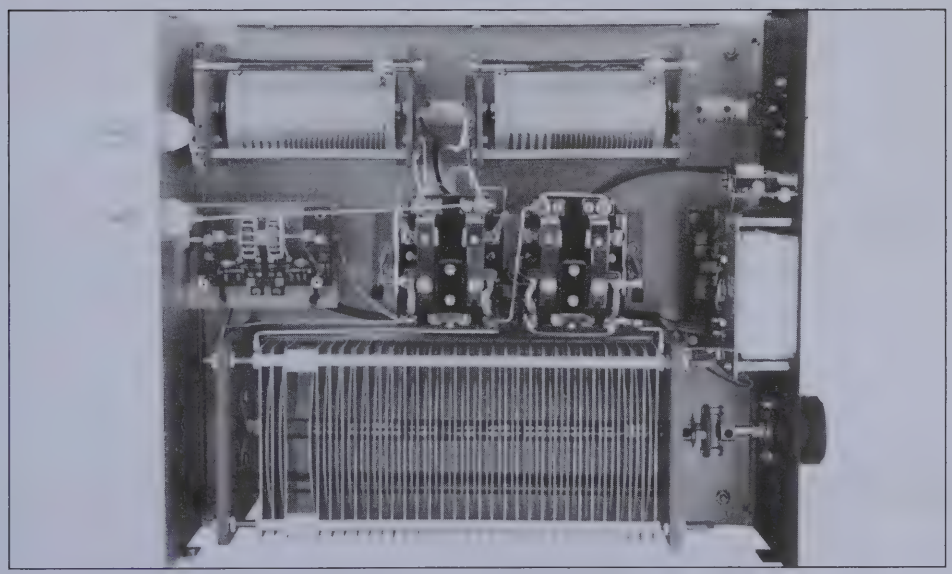


Figure 6—Inside the Palstar tuner, alsoo with dual roller inductors.

antenna couplers have a wider impedance matching capability than a typical transceiver's built-in coupler

High- or Low-Z—You don't have to make a choice. A switchable shunt element provides for both high and low impedance loads. See Figure 3.

A Balanced Coupler

So far, we've shown unbalanced couplers—these can be used with a balanced load in conjunction with a BALUN (more about that at FDIM 2021). Figure 4 shows AG6K's (SK) balanced tuner:

Notice where Richard Measures placed his BALUN, on the TX side of the coupler. There is an argument to be made that a BALUN on the transmitter side of the coupler is a better choice as it is working at its design impedance. Not everybody agrees with this notion. But Hey! If you're building a balanced coupler, put the BALUN any where you like!

Figure 5 is a photo of AG6K's tuner. This would be hard for the average ham to replicate because of the need for a pair of roller inductors driven in sync with each other.

The Palstar tuner (Figure 6) also has the 1:1 BALUN on the TX side of the coupler, the same as AG6K. This coupler also has a pair of synchronized roller inductors.

Combining Ideas

So, wanting a balanced coupler with a high-pass response and the ability to tune both high and low impedance loads, the schematic in Figure 7 was the result.

Note the switches which select extra capacitance needed to tune on the 80 meter band. The variable capacitor was 250 pF per section. The additional capacitance needed was 470 pF. If you need extra capacitance, the value can easily be determined by trial-and-error—tacking capacitors in the circuit.

The BALUN is 1:1. I have tried numerous BALUNs and the discussion of which BALUN to use is fraught with conflicting information. For this application, a number of turns of small diameter coax on the core of your choice (I used type 43) is probably sufficient.

As you can see in Figure 8, I used banana jacks and plugs to do the impedance switching. I would avoid attempting to use a switch here.

The two slide switches add capacitance

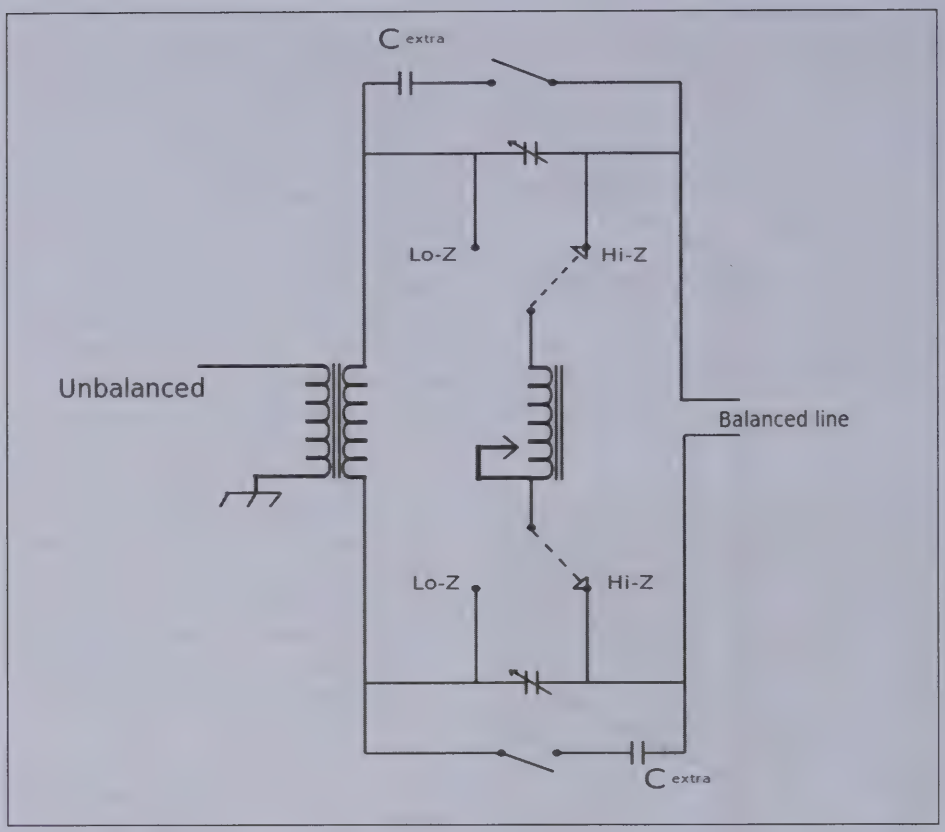


Figure 7—Diagram of the KI4IO tuner.

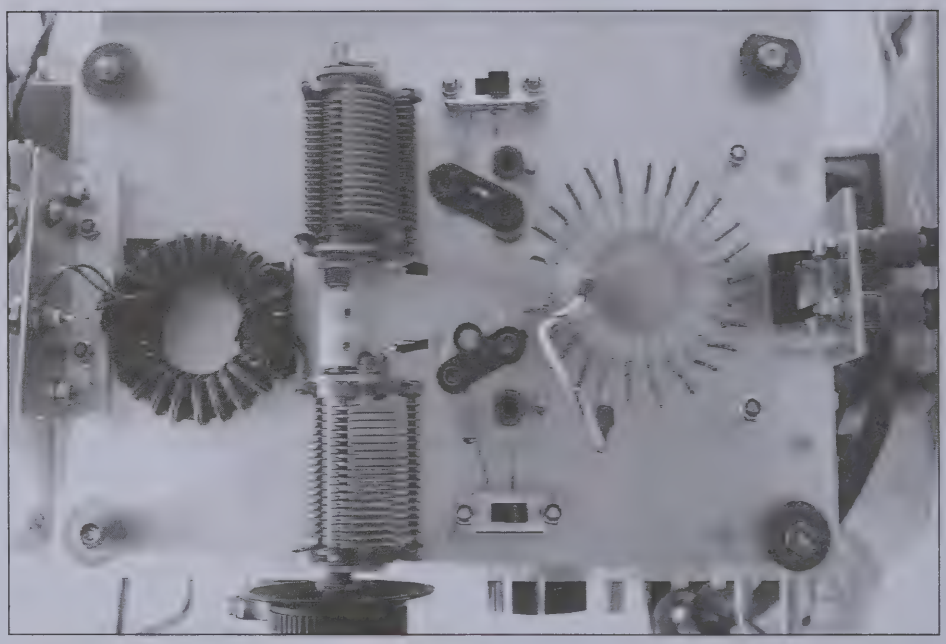


Figure 8—Photo of the tuner circuit layout.

in parallel with the two variables to allow tuning on 80 meters.

An insulated shaft coupling must be used to tie the two variable capacitors together. Try to make the construction as symmetrical as possible.

I used two pieces of plastic, one as the base, and the other as a platform to hold the toroid.

Figure 9 shows the bottom deck before toroid installation.

This is not an exact how-to article, but here a few notes:

- The builder should try to maintain symmetry.
- I think that BALUN could have been stood on its end, possibly making more room for a "fine" inductance control (see the conclusion).
- I used sheet acrylic which was a little too flexible. Thin plywood or bakelite would be a better choice.
- I used long machine screws and lock nuts as stand-offs.
- I could have made that toroid "platform" a little wider to accommodate some additional inductance.

Conclusion

It is interesting to compare this coupler to the one I intend to discuss at FDIM. That coupler is unbalanced, floating from ground, with a BALUN on the TX side of the coupler. In practice:

- Both couplers have similar (Excellent!) output balance percentage measurements (95% to 98%).
- When working into my 40 meter dipole, the Inductance and capacitance measurements are almost the same (observed, not measured)
- I have a fine incremental inductance adjustment on my unbalanced coupler but none on this balanced coupler. There does appear to be a need for fine tuning on this coupler as the higher bands (above 20 meters) cannot be perfectly

Be sure to check the club website often — www.qrparci.org —

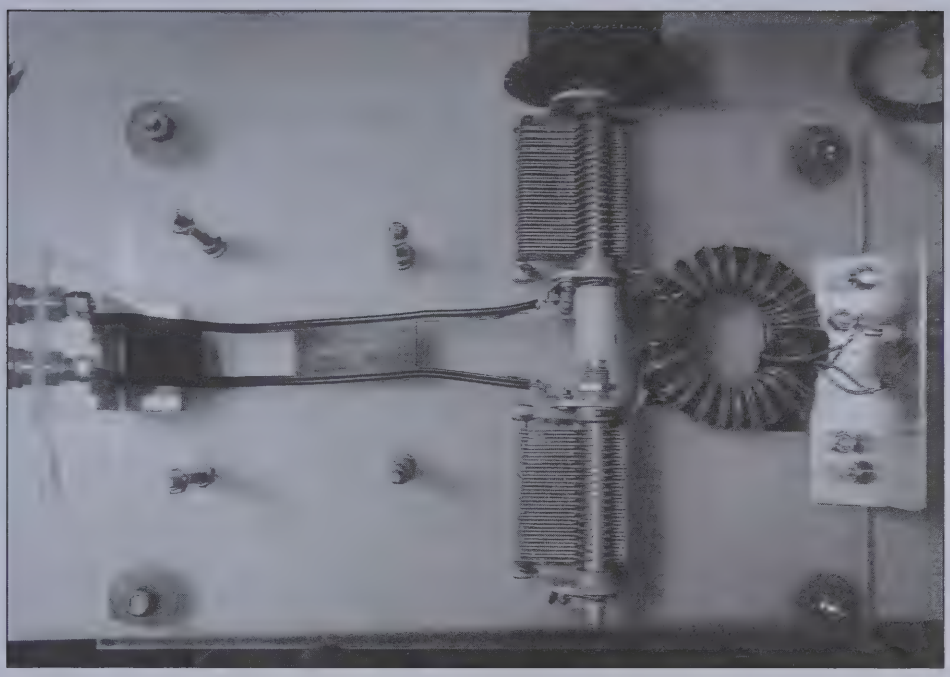


Figure 9—The bottom deck before installing the toroid assembly.

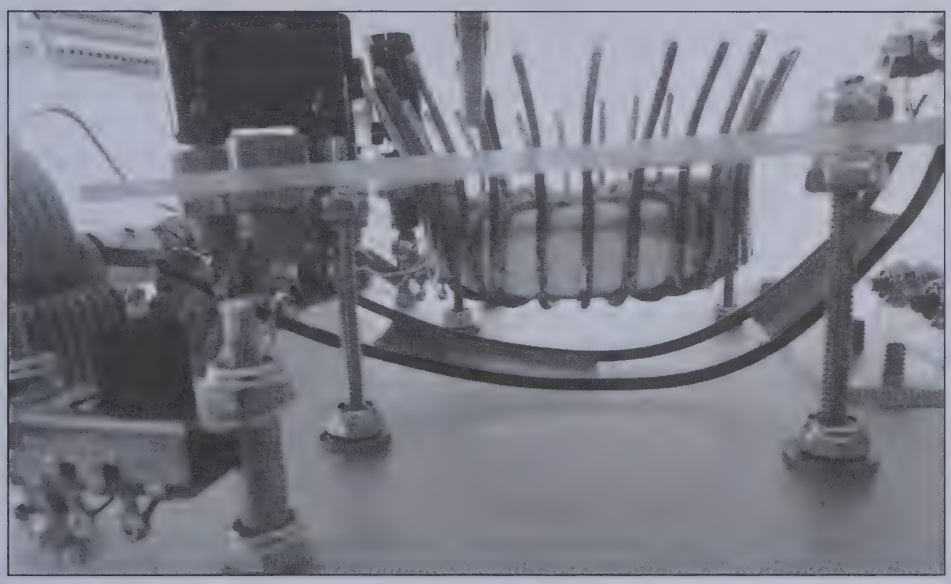


Figure 10—Close-up view of the toroid platform assembly.

tuned with just the coarse inductance steps provided by the large tapped toroid. A small toroid, like a T80-6, with 10 or 12 switched taps, in series with the large toroid, should provide sufficiently fine increments for use on the higher bands. Figure 11 shows what such a small tapped toroid might look like:

Figure 11—A smaller tapped toroid could be used for fine adjustment of inductance (especially on the highest bands).

Finally...

Preserve the memory of ARRL's Lew McCoy and make an antenna coupler!

—73, Jerry KI4IO

●●

for Membership, Contest, FDIM, Awards ... and much more info!

Review: The New RGO One HF Transceiver

Pete Meier—WK8S

Billed as a homemade QRP transceiver the RGO One is hardly that. Appearance, component selection and specifications befit that of any high quality commercial radio. With 5 to 50 watts, adjustable filtering, low noise floor and superb analog audio that DSP radios struggle to provide, the RGO One does not disappoint.

Background

The RGO One is the concept of pair of Bulgarian brothers Boris LZ2JR/AC9IJ and Lalyo LZ2LS. When reviewing current digital processing radios Boris determined they lacked the natural sound of an analog radio. He set out to design a radio that had both that natural sound and the performance provided by modern technology and be less expensive than commercial transceivers.Thus the RGO One was born.

It was first shown at Dayton 2018. Since its introduction he has been building and assembling the RGO in Bulgaria using a combination of machine soldering and hand assembly. Each radio requires about 50 man-hours to assemble, align and test.

Choices in a Digital World

In today's Amateur Radio market the race into future technology is evident as each year ham radio vendors add more and more high tech to our radios. The longer you've been in the hobby the more you can appreciate the advances and improvements. New and veteran hams face the same dilemma when shopping for a new transceiver. What features are important and which are needed for the type of radio operatingintended. Figure 1 shows the radio's front panel.

DSP—Digital Signal Processing—has been a significant advance in our radios. Digital signals are easier manipulated to filter and enhance but at a price. The analog signals that enter our radios at the antenna must be digitized, manipulated and then reconverted back to analog for our ears and brains to process. The cost is added circuitry, complexity and expense. This is where the RGO One shines. Through painstaking design and component selection the RGO avoids the complications of DSP using innovative superheterodyne circuitry design.

The Analog Choice

One of the strongest arguments for this analog approach is the quietness of the RGO. Its superheterodyne transmitter/ receiver utilizes a 9 MHz IF. With no signal or atmospheric noise present at the antenna input, as when the antenna is disconnected, the receiver is virtually silent. With the RGO's high sensitivity and dynamic range, this means signals can be heard down into the noise floor. The use of "clickless" solid state high speed GaAs pHEMT SPDT switches keeps the transition from transmit to receive quiet.

Another desirable feature is the variable crystal filtering. There are 10 selectable filters adjustable through the Menu. As the filter bandwidth is narrowed the noise drops away but signal strength remain constant. Weak signals "pop" out of the noise and become copiable.

Figure 1—The RGO One HF Transceiver: CW/SSB/AM, 1.8 MHz through 30 MHz, 5-50 Watts.

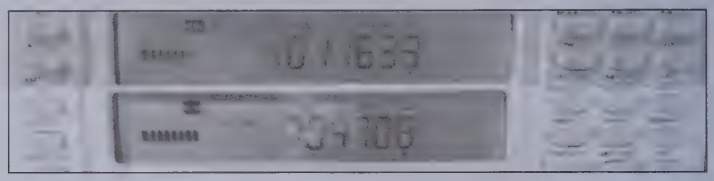


Figure 2—Two examples of the LCD display.

However, this is not old school radio. The use of two well shielded microprocessors to control radio functions and the display make operation of this transceiver easy and convenient. Silicon Labs SI-570 and SI5351 chips power the oscillators used.

The custom designed LCD display (Figure 2) with variable brightness and contrast along with adjustable color backlighting allows the user to personalize its appearance. Because it's transflective, it is readable in sunlight.

The RGO's internal construction is modular with no confusing "flying" wires going point to point inside make a clean looking interior (see Figure 3).

The cabinet is steel and aluminum and includes a collapsible tilt stand. The molded front panel is logically laid out with ergonomic controls. The main tuning knob is weighted with a unique rotating finger dimple. Tuning is smooth, effortless with no wobble.

The rear panel provides PowerPoles for DC input, USB for computer control (CAT) and digital modes as well as for upgrading the radio's firmware.

Additional connectors provided include IF out, Accessory in/out, PTT in, Linear, Paddle, Speaker, GND, Antenna and for options such as fans, Transverter in/out and Receiver in. The rear panel is shown in Figure 4.

Specifications are listed in Table 1.

Performance

In over 8 months of daily use I have found the RGO One to be the quietest receiver I have used in over 40 years. Since I am mostly a CW operator I tend to judge a transceiver first by it's CW

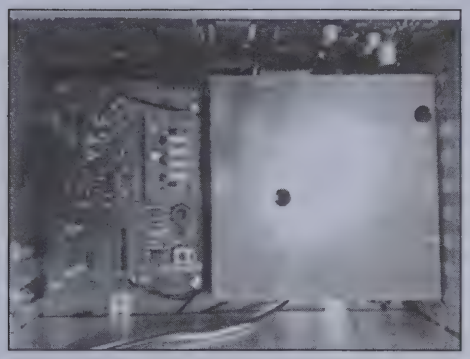


Figure 3—The interior of the RGO One is clean p.c. board-based layout.

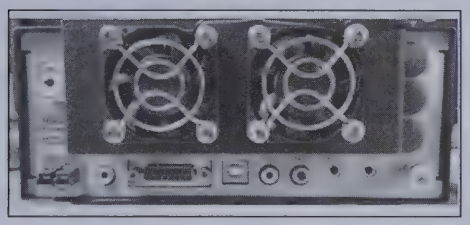


Figure 4—A look at the rear panel connections.

Size w/fans option	H 90mm; W 200mm; D 268mm	H 3.5"; W 7.9"; D 10.6"
Weight w/fans	2.67kg	5.9lbs
Supply Voltage	10.5 to 14.5 VDC	
RECEIVER		
Current Drain	Receive 0.65A with RX preamp ON	Transmit 10.5A typical @ 50W out
Radio topology - IF	Single conversion superheterodyne RCVR/ TCVR	9MHz IF
Senitivity (MDS)	-135dBm (preamplifier On; VBF filter 2)	-129dBm (preamp O ; VBF filter 2)
Selectivity	Crystal 8 pole 2.7kHz first roofing filter at 9MHz - Crystal 2-pole IF noise filter 9MHz	0.2-2.7kHz second variable filter Johnson type 9MHz
Dynamic Range	96db (Preamplifier On; VBF filter 2) Two Tones Close Spaced (2kHz)	99db (Preamplifier O ;VBF filter 2) Two Tones Close Spaced (2kHz)
TRANSMITTER		
Power Out	50W on CW; 40W PEP on SSB	Adjustable 5 – 50W by 1W steps
CW Sidetone	Adjustable frequency (400-800Hz) volume adjustable	independent from AF volume
Carrier Suppression	45dB minimum	
SSB Suppression	45dB minimum	
Duty Cycle	50db minimum	

Table 1—Transceiver specifications.

performance and secondly for it's ease in Sideband operation. The RGO does superbly in both. The built-in Curtis CW keyer is excellent with the exception of a minor flaw in the displayed speed readout.

The display indicates about 3 words faster than the actual speed. This is promised to be fixed in an upcoming firmware update and doesn't affect performance. I've received only good reports on the RGO's CW note during my QSOs from QRP through QRO at 50 watts. The transition from transmit to receive is seamlessly quiet and can be as fast as 10 milliseconds QSK to 1.2 seconds delay. Sideband reports have consistently reported great audio. I like that there is no fiddling with controls other than adjusting mic gain for proper ALC limiting. This means "set it and forget it".

Frequency tuning on the RGO is a dream. The weighted knob and rotating finger dimple make changing frequency fast and ultra smooth even across large swaths of frequencies. Fine tuning is easy down to 10 Hz.

Sensitivity (MDS) is rated at -129 dBm. With careful tuning and use of the filters I can hear copiable CW signals down into the noise that I would never suspect were even there viewing a Panadapter. The Preamp can be left off most of the time and the Attenuator used without losing weaker signals.

The Split function works smoothly and as expected with receive being the frequency set in the current VFO with transmit from the other VFO. This can include cross-band split. A touch of the VFO A/B button allows you to monitor the DX station receive frequency.

I like that the RGO keeps the radio's operating features push button and knob accessible without having to dive into a menu. Going into the Menu is reserved for feature setup not normally done during on-air operations.

The Perfect Rig?

Nothing is perfect. While there is little to complain about the RGO there are some points to consider. Several mentioned features and options are still under development. To many folks considering the RGO, these missing items are not a game changer but for some they could be. Several hardware options not available at the time of this review include the Noise Blanker module, Audio Filter module, Speech Processor/Voice Keyer module, Transverter module and Receive Antenna module. Firmware features not available include Beacon mode also used for CW message repeat, Squelch mode and CPR—counts per revolution of the Tuning dial.

Pricing

The RGO One-Base unit assembled and tested is 790 Euro, or approximately US$934.

A fully loaded unit is 1169 Euro, or approximately US$1379. See the website for an options list (http://lz2jr.com).

Support

Support for the RGO One has be exemplary. Email replies from Boris are always friendly and timely. There is a online users group at groups.io that also provideshelp and advice. The users group address is https://groups.io/g/RGO-ONE/.

Conclusions

In a market dominated by expensive SDR radios the RGO One is a breath of fresh air. It's analog approach uses a refined classic superheterodyne design. With uncompromising circuit and component selection it provides a high performance not found in its price range. The intelligent use of microprocessors for control and information display make it easy to use and keep it competitive against the army of SDRs available. It retains the feel and fun of operating a "real radio". ●●

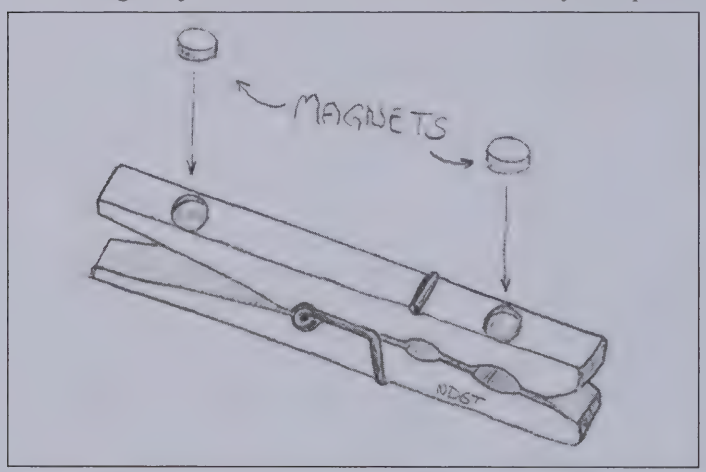
Doohickeys and Thingamajigs

Don Cantrell—ND6T nd6t@velotech.net

Throughout history, every workbench has had them; those indefinable little tools and accessories that every builder and repairman fashions from pieces and parts to get the job done. Here are some of mine.

Clothspins

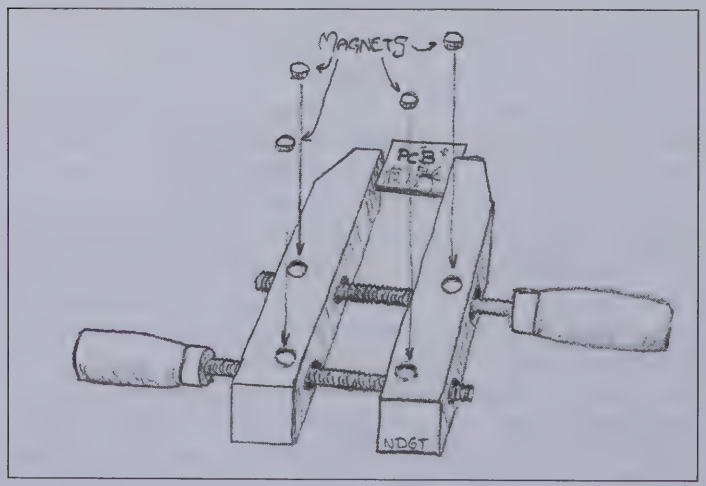
When your working down close to the surface inside a baking pan "play pen" looking through a microscope while working with SMD parts you need a stable third hand to hold a board or sub-assembly. Often there is no room for the usual vice or assembly fixture. When you are soldering a cable to a connector you need a stable clamp or two. I find that the common wooden clothspin works quite well. I carve out a couple of holes on one side that are just large enough to insert and glue two of those little neodymium button magnets just below flush to the surface. They clamp onto



the pan or steel bench top easily but do not scoot. They also clamp to many steel panels and supports on equipment cabinets for holding cables and connectors in place while soldering. The wood surface makes a good grip and does not sink heat from the piece but takes abuse in stride. If you damage one, replacement is nearly free.

Handscrew Clamp

Tom, K9AC, has been innovating bench vises for years and recently sent his latest idea: using an off-the-shelf handscrew



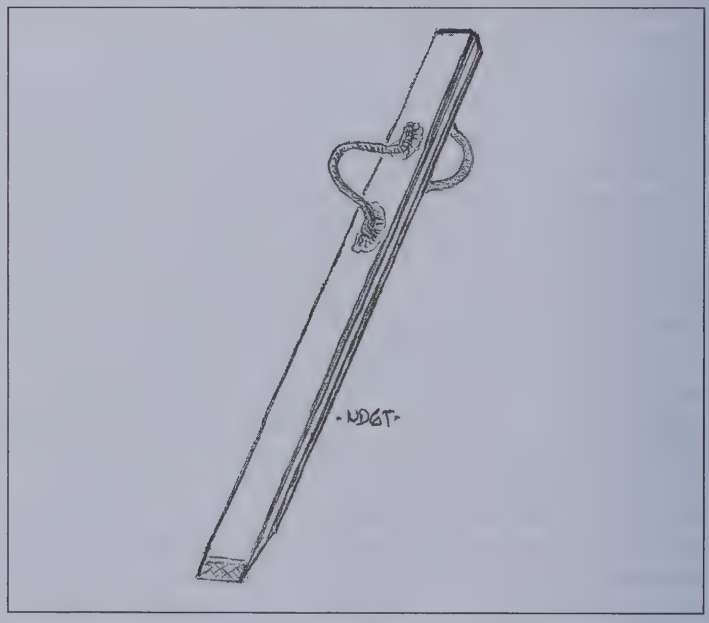
clamp to hold those PC boards during assembly. Much easier than the watchmaker's vise that I have been using. Woodworkers are familiar with the age-old handscrew; They are used to hold a couple of pieces together while gluing. I had several 5" clamps in the woodshop and grabbed one for the bench. It adjusted easily for my small boards, was low enough to permit usage under my microscopes, but was thick enough to permit flipping it over with leaded components installed while I soldered the underside of the board. Cheap and easy!

To keep it from skidding I grabbed 8 of those powerful button craft magnets and just dropped them into the pivot holes where they snapped solidly to the ends of the internal swivels. They are not easily dislodged but grab the steel bench (or pan) surface quite well. No glue needed!

Current Probe

Just a sliver of scrap un-etched double-sided printed circuit board and a couple of wire clippings from the last time you used a leaded component. Bend the leads into an "omega" shape and solder one on each side of the board.

Insert it into a battery holder either between batteries or

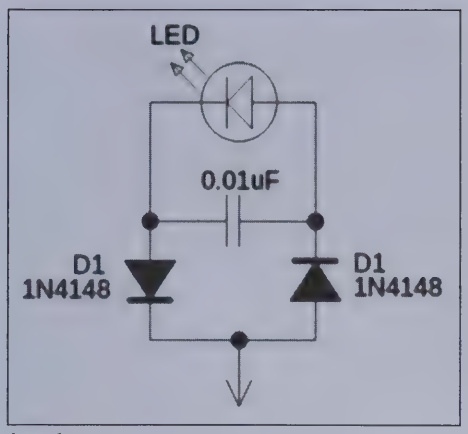


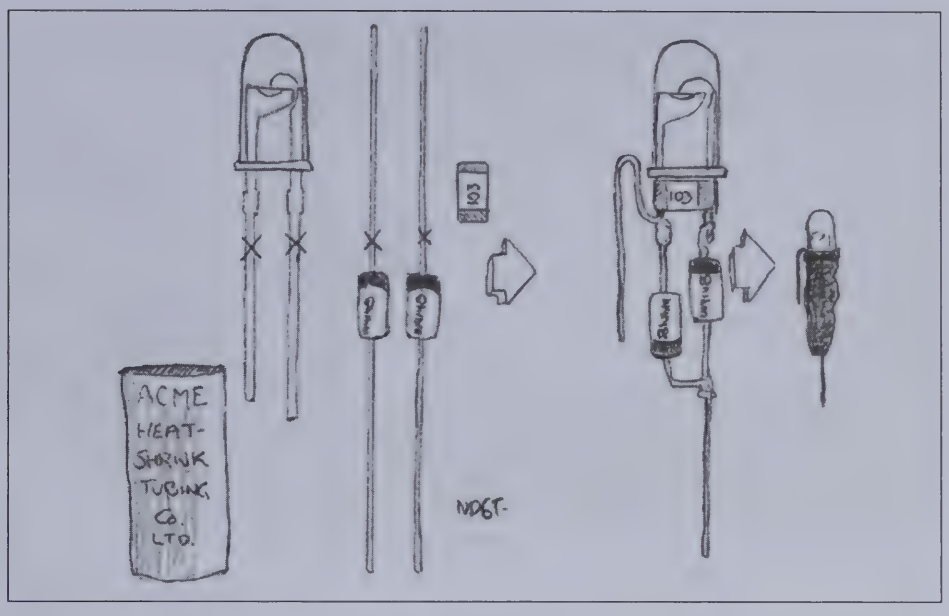
between the ends of a cell and the holder contact. Clip an ammeter test lead to each loop and measure the current flow. I make the loops large enough to let me slip a test probe through if I want to just hang the leads there without attaching clips. Filing the end of the strip to a wedge shape makes insertion easier.

This is an excellent way to check the charging rate of the battery pack or monitor the current drain of a battery powered device.

RF Probe

Back in the days of vacuum tube equipment a little NE-2 neon bulb stuck in the end of a clear soda straw served as a quick check for RF voltages on antennas and in the drivers and finals of our transmitters. This was often the first steps to diagnose a problem





in a hurry.

Later, I was introduced to the scary idea of using an incandescent bulb for doing much the same thing while repairing VHF and UHF mobile transceivers in a commercial environment. These were indicator lamps with big glass bulbs and you used a small lead soldered to the tip of the screw base as a probe while pinching the glass envelope to provide a capacitive return. How I avoided RF burns is something that I still marvel. It worked, but I do NOT recommend it!

In the May 1997 issue of *RadCom* magazine G4TKV introduced the idea of using a Light Emitting Diode in place of the neon or incandescent indicator, thus enabling use at lower RF levels. Others (GM3OXX and GØGQX, in particular) have made gradual improvements on the idea. Presented here is my current version, the design that has been in use for the past 20 years or so (diagrams above).

Two general-purpose switching diodes in series with the leads of a high-output LED and a little 1 nF bypass capacitor across the LED itself. The cathode lead is brought out to be grasped by the fingers as a return for the RF but the probe end is insulated by a short piece of heat shrink tubing.

Grasp the plastic portion of the LED together with the bare conductor next to it. Hold the probe tip near a rubber ducky antenna to see if it lights when you transmit.

On the bench it works to "walk" down the chain of RF output stages until you see the signal disappear. A quick check to see if signal is getting to the antenna. I've also used it to track down stray RF in the shack by touching cabinets, connectors, and such while transmitting. Open grounds and loss of shielding show up quickly. It's a fast way to tune your antenna counterpoise in the field.

Several years ago our county law enforcement radio system was made unusable by a mystery signal that blocked the local repeater. I was able to use my Doppler RDF to trace the problem to the State Highway Patrol office... but which car in the parking area? I used one of these probes to walk down the line of patrol cars, holding it near each antenna. Within minutes it lit, pinpointing the radio that was stuck in transmit mode.

Sewing Pins

The little straight pins, particularly those with the spherical plastic heads, are quite useful on the test bench. I often keep several, of various sizes, on magnets nearby. They make excellent voltage probe extensions for accessing those hard to reach test points midst tightly-packed components. Just slip an alligator clamp to the end of your test probe and use it to hold the pin while you maneuver it into position. You can use thumb pressure on the enlarged pin head to pierce solder mask and other conformal coatings so that you can contact the conductor trace beneath.

They also make it possible to troubleshoot heavy plastic or rubber insulated wires. Just slip it through the insulation to make contact within. You now have a test point. Just keep in mind that the wire is exposed to accident while you do this! If you work on "live" circuits then always remain alert and mindful.

I usually keep one large pin that I have bent the last 1/4" in a 90 degree "L". This is useful for retrieving a dropped nut or washer in an impossible corner of the chassis or the like. It is also good for prying up one end of a component or wire when gripped by needle-nosed pliers. Little sharp extensions for my fat fingers.

Need it to be magnetic (for hardware or wire clippings)? Just place one of those button magnets somewhere on the side of the pin and the entire pin becomes magnetic enough to retrieve the hardware.

When some new challenge appears, look around you and see if you can re-purpose something nearby or cobble together something to get the job done. Then consider keeping it ready for the next time.

Now, where did I leave that whatchamacallit doodad?

—de ND6T

Peripatetic Morse (PM)

Paul Signorelli—WØRW w0rw1@msn.com

Definitions

Peripatetic—Pedestrian, itinerant; journeys hither, thither and yon.
Morse—Morse Code; an original digital format.

In the Beginning…

My first exposure to PM was when I had just taken my Elecraft KX1 out to the field. It was in Elephant Park, west of Denver.There were no picnic tables available, so I picked up my KX1, Put my 10 foot whip in my rear pocket and hooked it to the antenna jack and the KX1 tuned the thing right up. I was on 20 meters and made a few contacts out 1,000 miles. I was out on a looping trail and it had steep sections with trees to dodge. But it worked. I didn't realize that I could send morse code while I was hiking around the trails.

Sending

I hold the KX1 in the left hand and key with the right hand. I don't use iambic keying so the rough terrain didn't affect my sending at all. My arms seem to swing back and forth as I walk but the spacing of my hands stayed the same. There is a picture of the KX1 in operation next to a 4 foot Oshkosh snow blower on Pikes Peak.

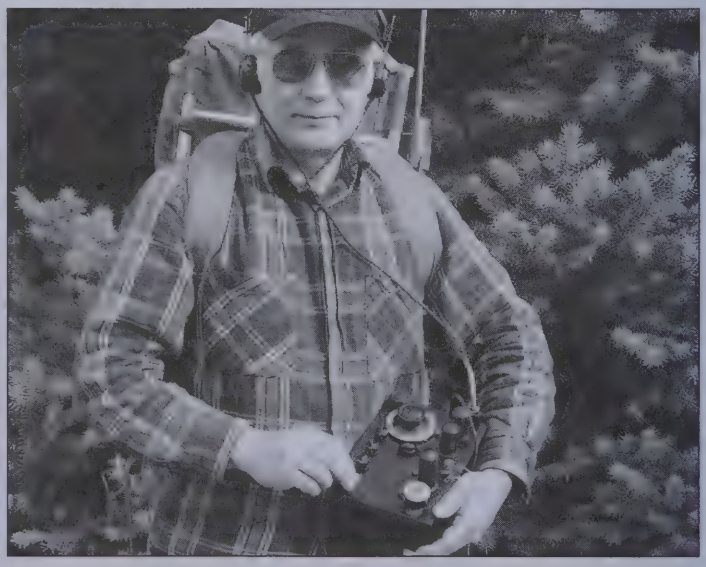
I have also have used a straight key. The one that is mounted on my Paraset is very easy to use while walking. I hold the Paraset radio in a "football carry" under my left arm and key with my right hand. See the Paraset picture.

My main single lever key for my backpack radio, the PRC319, is the Whiterook. It is just a little plastic jewel box with a lever, 2 inches by 2 inches. See the Whiterook picture, My modified Whiterook is green, or you can see it in the W7L video: http://tinyurl.com/zw8mgkn

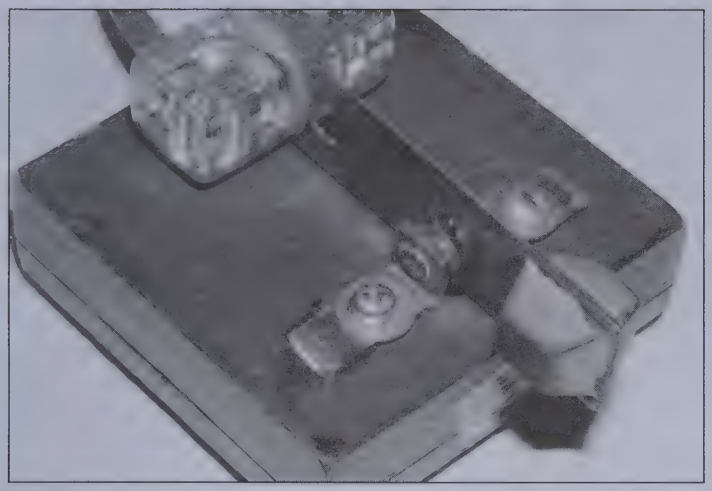
Receiving

The reception of Morse while walking is going to be difficult if you have not gotten up to a speed where you can copy in your head. The ability to copy 30 wpm (Copying words, not letters) is a very great asset. If you can only copy code sitting at a desk writing it down letter by letter, you will not have any fun walking down the road trying to copy it, but it may help you learn. See my story "The Secrets of High Speed Morse", *CQ Magazine*, Jan. 2018, p. 26-27, or eHam Article at https://www.eham.net/articles/41222

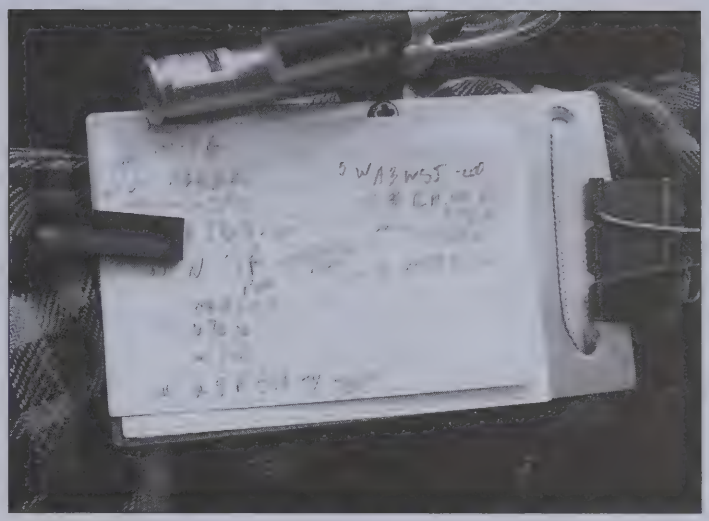
Standing by a BIG snowblower.



I carry the PRC319 under my arm.



The little single lever key.



My cuff log is attached, not carried.

I use a "Cuff Log" (Like the NFL quarterbacks use for play calls), to record calls and names. See the cuff log picture. When my XYL is with me she does the logging.

Noise cancelling earphones are helpful to block out wind and extraneous noises.

Social Distancing

Social distancing has always been my norm while operating with my high power (50 watts) PRC319 because the nearby RF could stop a person's implanted pacemaker or trip off a defibrillator.

If you are out hiking and hear hissing noises in your receiver you may have to relocate or shut down because of power lines or precipitation static. Precipitation static is what you hear right before you are struck by lightning. Operation at high altitudes should be done with a DC short across your antenna (Like a quarter wave shorted coax stub).

WA3WSJ (Ed) and I were hiking to Devils Head Fire Lookout (SOTA W0C/FR-051) one day and we had to stay 100 yards apart to prevent desensing our receivers. We started from the parking lot in a deep canyon and as we got to the east ridge, we started to work stations on the east coast. Then Tac JA7QVI called me, followed by DL1VBN Ed, DJ5AV Mike, EA4CWN Alfonzo and 36 others. They didn't count as SOTA contacts because I was not at the top yet. 90% of my contacts were made coming and going on the trail. The full story is in *QRP Quarterly*, Winter 2014, p.45-50, "Colorado QRP Pedestrian Mobile or Bust", by WA3WSJ.

Antennas

To be Peripatetic you have to have a good antenna that allows you to move around. I don't think a loop would be a good choice. I use a whip; center-loaded and 10 feet long. It attaches to my backpack frame. It has a quarter wave radial and allows me a lot of freedom when hiking around. You should put a quick disconnect "break away" connection on the ground wire in case it snags. An automatic tuner is a must because you, the ground and your antenna are going to have different characteristics than a static test on a step ladder. The Elecraft Tuner T1 is excellent.

Also, wide trails without trees are helpful. Hiking above tree line is the best.

Equipment

Many additional helpful equipment ideas can be found in WA3WSJ's *Pedestrian Mobile Handbook* by going to:

http://w3bqc.homestead.com/files/Amateur_Radio_Pedestrian_Mobile_2nd-Edition_-_Edward_Breneiser.pdf.

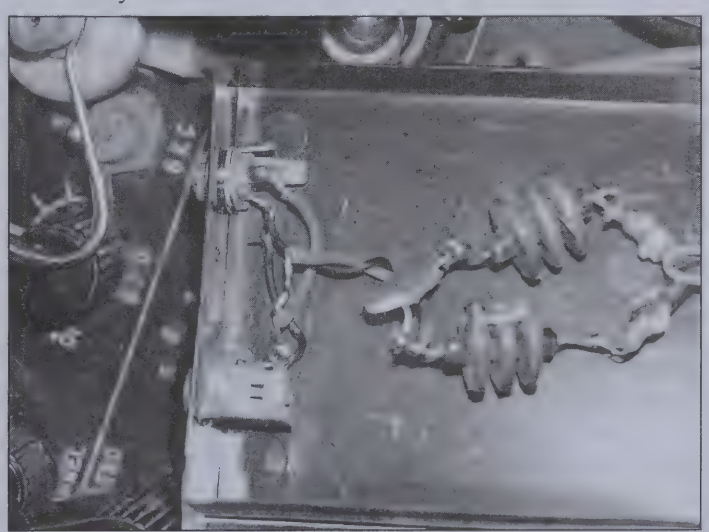
It's a PDF free download book filled with good stuff about what equipment to use and how to operate a pedestrian mobile station.

Batteries

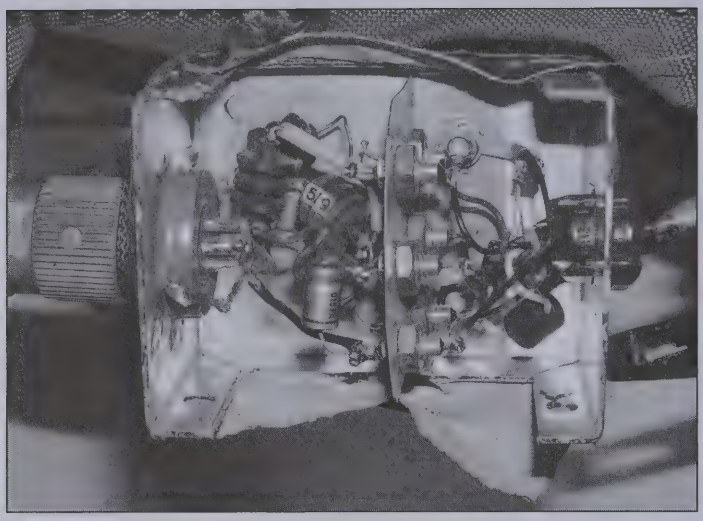
Lithium Ion batteries are the best. They give twice the energy with half the weight. Life is too short to carry lead acid batteries around.

EMI/RFI

Everything attached to your backpack rig is part of the antenna. Depending on your transmit power, cables may need to be shielded and/or decoupled from the RF or they may fail. That includes keyers, headphones, microphones, modems, message units, etc. See the picture of the 2 RFC headphone filter. It keeps RF out of your ear.



A headphone filter keeps RF out of the audio.



Another filter prevents RF from messing up the microphone.

Even battery controllers can fail from RF intrusion. Ferrite filters can help but cables must be kept short. Keyers can become erratic, modems can freeze and battery controllers can just shut down.

If you wish to work SSB your microphone should have a separate microphone return wire. Poor microphone shielding or common grounds can cause RF feedback and noise. See picture ofthe microphone filter.

How Well Does It Work?

The effectiveness of Morse Code when propagation is poor is widely known: https://mtechnologies.com/pubs/qrp.htm

The effective gain for Morse vs. SSB has been calculated at +18 dB, That's 3 S- units, a huge difference. 5 watts of Morse, by this equation, is equivalent to 240 watts of SSB. In addition if you know the call sign, time and frequency of the station you are trying to work just increases the probability of success. It all depends on propagation so generally speaking you won't have a lot of success when the A Index is above 15.

It really works, check out the story: "210 Countries on a 10 Foot Whip", http://www.eham.net/articles/10734

I always start my operation with the Reverse Beacon Network protocol. (Calling: CQ CQCQCQCQCQ DE W0RWW0RW W0RW/pm). If you don't use that protocol the RBN won't post you. After my operation I always check the RBN to see which RBNs heard me. So I get reports even if I don't make any contacts. http://www.reversebeacon.net/srch.php

Additional Stories

There are 46 more PM stories (12 MB) in the "W0RW Pedestrian Mobile Stories" book at: http://w3bqc.homestead.com/W0RW_pm_Stories_2011.pdf

Next time you are out at the park and all the benches are taken, give it a try!

—73, Paul WØRW

●●

Side-tone Injection in Homebrew QRP Transceivers

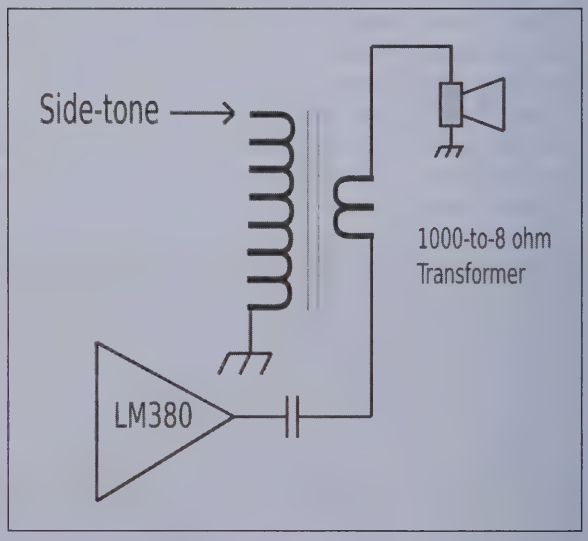
Jerry Wolczanski—KI4IO

I've frequently said, "Building a receiver is easy. Building a transmitter is also easy, but getting them to play nice together (a transceiver!) can be challenging." One of the more vexing problems, at least for me, has been the issue of side-tone injection. Where to insert the side-tone, what frequency should it be, and how to control the volume?

I typically will build breadboard style which allows for considerable tinkering before a project is committed to its final enclosure. I've stolen the designs of others, prowled the internet, and have still been thwarted in coming up with a solid "fix".

As most of us are now using audio amplifiers like the LM386 or the LM380, which have low-Z outputs, just injecting a side-tone into the transceiver audio output is problematic—most side-tone circuits cannot drive a low-Z load. I even built an LM386 amp for one side-tone, but I thought that fix was the wrong approach.

So when you stare at a problemlong enough, sometimes the fix just reveals itself! In this case I used a small audio transformer and injected the side-tone into the high-Z side and routed the LM380 output through the low-Z winding.



Problem solved!

If the side-tone audio is too much, a gain control on the output could be installed. The side-tone can be any frequency if the transceiver has internal audio filters. If you're using an outboard audio filter, then the side-tone frequency will need to be matched to the center frequency of the outboard filter.

I'm using a rather robust side-tone circuit from Wes Hayward's (W7ZOI) Universal QRP Transmitter. The schematic can be found at: http://www.arrl.org/files/file/Technology/ tis/info/pdf/0604028.pdf

Enjoy!

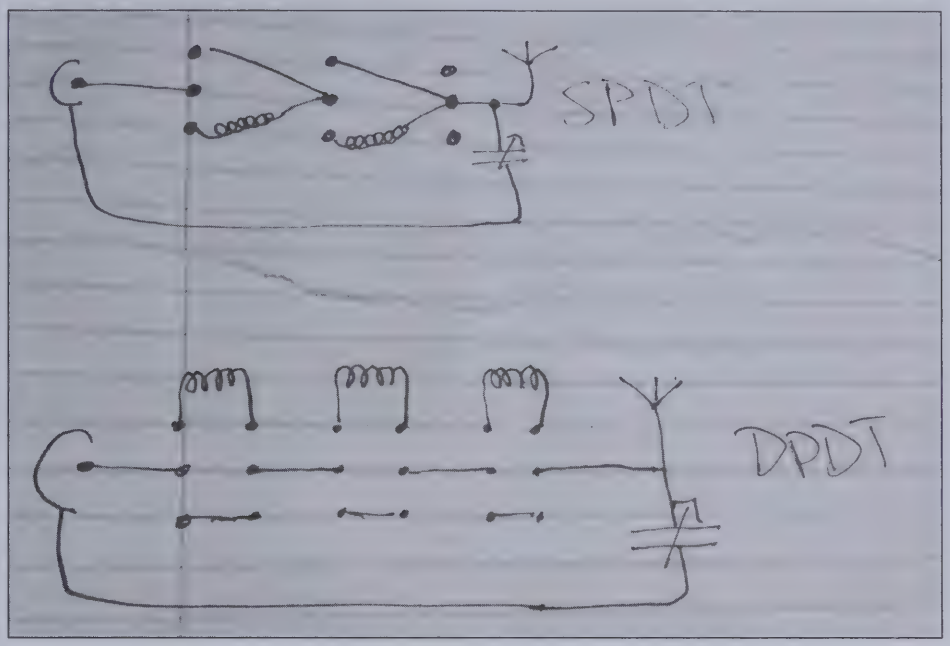
Build an L-Match Tuner for Your Wire Antenna

Ryan Flowers—W7RLF geocrasher@gmail.com

In this article we're going to build an L-Match tuner for your QRP wire antenna. You might ask: Why do I need a box between a bit of wire and my transmitter? That's a good question!

Amateur radios are constructed in such a way that they have an impedance of 50 ohms. Many antennas also have a 50 ohm impedance, and for those there is no extra circuitry needed. But many excellent antennas don't have a 50 ohm impedance.

An end fed antenna is often desirable due to its ease of setup, but their feed point impedance can be several thousand ohms. If you try to transmit directly into the end fed antenna it will work very poorly, perhaps even damaging the radio!



Schematic diagram of the L-Match Tuner.

Enter the L-Match Tuner

An L-Match tuner is a device that can add either inductance (L) or capacitance (C) to the antenna feed point. The added inductance or capacitance bridges the gap between several thousand ohms and 50 ohms, thus matching the wire antenna impedance to the radio's 50 ohm impedance.

Is this an unusual thing? Not at all. Radios are full of tuned circuits. When a particular part of the radio needs to operate at something other than 50 ohms, then it'll have added circuitry to make that happen. In this case, the antenna wire is such a circuit, and so you are using other components that are adjustable to make the circuit resonant on your desired frequency, just like you would any other part of the radio.

Let's get started with the build!

Gathering the Parts for the L-Match Tuner

The L-Match needs a variable capacitor, some inductors, and a way to switch those inductors in or out of the circuit. We also need to connect it to the radio and the antenna, and you will want to build it into some sort of enclosure. For information about all parts used in this build, see the URL at the end of the article. You're encouraged to look around to see what parts you might already have and improvise with whatever you can find. That's part of the fun!

Variable Capacitor

The first component to look at is a variable capacitor. Variable capacitors come in different styles. Popular in QRP construction are the "varicon" capacitors found in portable AM/FM radios. These can be salvaged, or purchased new. These work fine for up to 5-10 watts. They are also more delicate and harder to find a knob for.

For these reasons, I used an air variable capacitor in my tuner. They are easily sourced on eBay or Amazon. You'll want to find a single section capacitor with a maximum value over 300 pF. A search for "365 pF variable capacitor single" will get you started.

Inductors and Wire

Our L-Match antenna tuner also needs inductors. Rather than using a multi-tapped inductor, we're going to make several small toroidal inductors to switch in and out of the circuit.

I used two T50-6 and three T37-6 toroids because that's what I had on hand at the time, but I would recommend that you use all T50-6s. You can purchase 25 T50-6s at kitsandparts.com for a few dollars. A homebrewer can never have too many extras!

If you already have similar toroids on hand with the -6 suffix in their part number, then you can use those—just be sure to calculate the number of turns to get the correct inductances mentioned later on. You can find an online calculator http://toroids.info

A length of 24-26 AWG enameled magnet wire is used to wind the toroids. If you buy your toroids at kitsandparts.com, then get the 10 feet of 26 AWG (solder heat strippable) wire at the same time. It's very inexpensive.

Switches

To switch the inductors in and out of the circuit we will need five toggle switches. Miniature DPDT switches are what I used in my build because I already had them. You can use SPDT switches too.

Project Box

For your L-Match tuner, you're going to want a chassis that has at least one metal side to use as a common ground. I used a plastic Radio Shack project box with a metal cover, and built the whole tuner on the metal cover. Feel free to get creative, and use whatever you have on hand, it will probably work fine. The only thing to stay away from is metal grids and meshes such as those found on PC power supply cases.

Connectors

A panel mount SO-239 or BNC connector will connect to your coaxial cable, and binding post terminals will be used to connect the antenna wire and counterpoise. If you don't have binding post terminals, then small bolts, washers, insulators, and wing nuts from your local hardware store will suffice.

Building The L-Match Tuner

This project was inspired by Peter Parker, VK3YE. One of his videos presented a tuner where he switched out fixed inductors instead of having a variable inductor. We'll go ahead and use his inductance values: 4 uH, 2 uH, 1 uH, 0.5 uH. Peter uses just the .5 uH through 4 uH inductors but I wanted to have the flexibility of just a bit more inductance, so we'll add an 8 uH inductor.

Using T50-6s, these inductors should have 44 (8 uH), 32 (4 uH), 22 (2 uH), 16 (1 uH), and 11 (0.5 uH) turns. That means that each T50-6 should have a wire going through the middle once for each turn. If you lose count, don't worry. Just count the turns on the inside of the toroid and add enough until you have them all. If an inductor is missing a turn or has an extra, it's not a big deal. The fine tuning is done with the capacitor anyway.

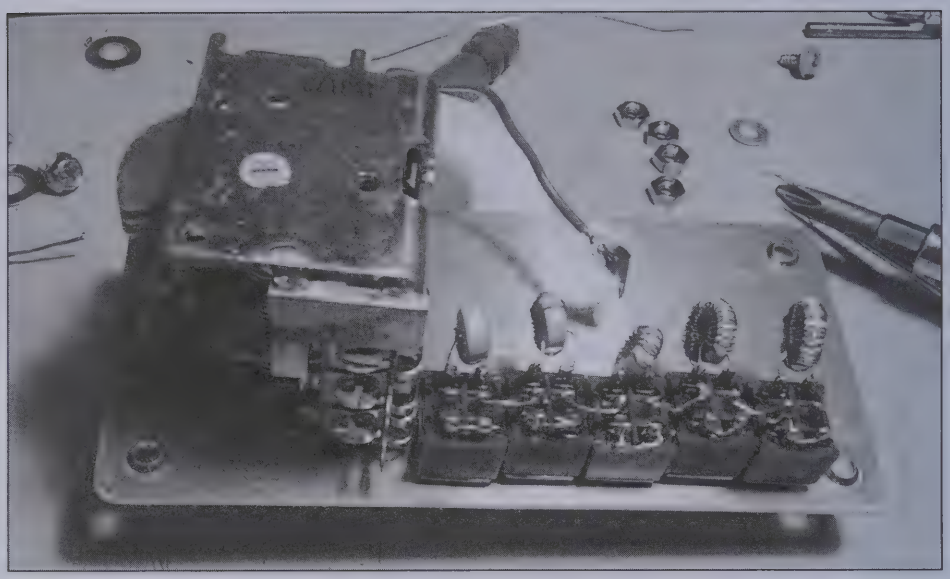
Clip the leads so that they are about half an inch (12-13 mm) long, and hold the ends in a solder blob until the ends are tinned. Check continuity with your DVM to make sure that the enamel is completely stripped.

I highly recommend reading up on how to wind toroids by looking at the QRP Labs instructions for the Band Pass Filters as the process is much the same.

Next you need to wire your switches. For this, a third hand and a pair of tweezers might come in handy. The schematic below shows just a couple of inductors to show you how to wire them. DPDT and SPDT switches are shown from behind.

On the left of the diagram is the coax connector. The center conductor runs through the switched inductors and on to the antenna connector. The variable capacitor is wired between the antenna connector and the coax ground.

I put the smallest inductor on the right side when viewed from the operating position. The inductors (8, 4, 2, 1, and .5) give 16 combinations between .5 uH and 15.5 uH.



Here is the layout of the assembled tuner, showing the switches and inductors.

You'll notice that in both wiring diagrams the inductor is either used or bypassed depending on switch position. The capacitor is positioned near the output in order to keep the leads as short as possible. It's best to use a metal chassis as a common ground, if possible.

The red terminal connector is for the antenna wire, and must be insulated from the chassis. The black terminal connector should be grounded to the chassis. Run a wire from the coax ground to the chassis using the terminal connector. If you bolt the capacitor to the tuner chassis, you won't need any extra ground wiring.

Check Your Work

Check continuity from the center of the coaxial cable connector to the red antenna connector, and make sure that each switch has continuity in both positions. You can do this by switching all of the inductors in, checking continuity, and then switching all of them out and checking continuity again. If there's a break in continuity, just flip the switches one at a time until you find the break. You might have to warm up an inductor connection to make sure the enamel is fully removed. Once your continuity check is complete and your L match is in its chassis, that's it. You're done!

Your new tuner can be used on all kinds of antennas—verticals dipoles, loops—but we're going to apply it to a very common QRP antenna: the end fed random wire.

Setting up the Tuner and Antenna

Your new L-match tuner is straightforward to use with a random wire antenna. By random wire, we mean just that- a random length of wire. Whatever type of wire you can get access to will work. For example, I've used wire salvaged from CAT5 cables for a long time. It's not optimal because of having many splices in it, but it works fine.

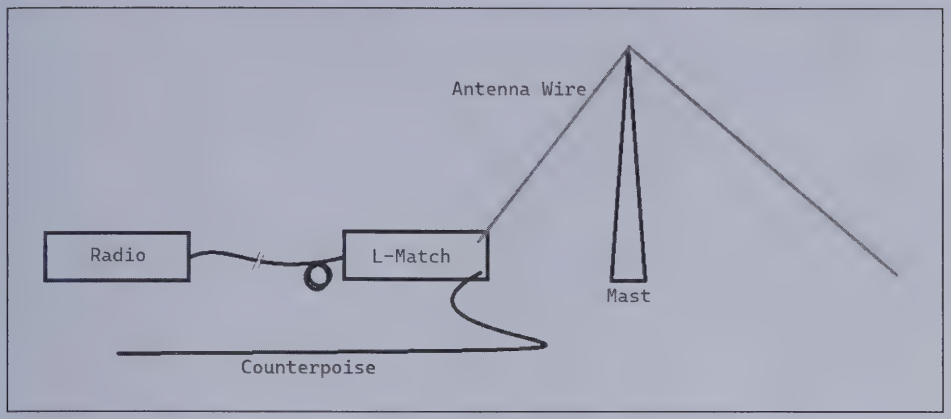
You'll need two lengths of wire for your antenna: one at least 40 feet long (longer, if you expect to operate 60m or 80m) and another 10-15 feet long. These are your antenna and counterpoise wires.

Attach your antenna wire to the red output terminal of the L-Match, and connect your counterpoise to the ground terminal. The counterpoise can simply lay on the ground.

Connect the coaxial cable to the tuner and run it to the radio. Try to get the antenna wire up in the air as much as possible. Jackite brand kite poles are 10 meters (33 ft) tall and are excellent for getting antennas up in the air, as is a tree or pretty much anything you can use as long as it isn't metallic. You can also purchase inexpensive fishing poles on eBay for around 15 dollars US.

If you can't get your wire into the air, don't despair. Run it along the top of a wooden fence, or over a non-metallic roof. You'd be surprised at how many non-ideal antenna installations still make plenty of contacts on the air!

Lastly, If you run into issues with RF



One possible antenna configuration.

coming back to the radio, coil up the last few feet of coaxial cable next to the L-Match. This will act as a choke and keep the RF out of the shack.

It is important to note that the best place for the tuner is not directly connected to the radio, but directly connected to the antenna. This causes the impedance match to happen directly at the antenna and prevents high losses due to carrying the high impedance over 50 ohm coax. For a more permanent installation this is clearly less convenient, but the results are much better.

Tuning the Antenna

If you have an antenna analyzer, connect it to the tuner with a short piece of coaxial cable. Set the capacitor to its minimum setting and bypass all of the inductors. Start by adding one inductor, and then turn the capacitor knob to see if you can get a low SWR. It's good to be methodical about this: Start with 8 uH, then 4 uH, then 2, 1, and .5 uH. You'll find that a combination of these will likely be needed to find a low SWR. I usually find an SWR of less than 4:1 using inductors alone, and then add capacitance to get the lowest match I can, which is usually 1.3:1 or less.

If you have an SWR meter, then simply key down on an open frequency at your lowest power setting and adjust as previously mentioned. Don't flip the switches while you're transmitting though.

SWR isn't the only thing that matters. Tune lower and higher than your target frequency. If your target is 7.2 MHz, then your SWR should be lower than 1.5:1 at 7.2 MHz, but 2:1 or higher at 7.1 MHz and 7.3 MHz. If you find that your SWR is low over a broad frequency spectrum (several hundred kHz) then you need to find a different match. The best match will have a somewhat narrow SWR bandwidth of +-100 kHz or less. If you can't get such a match, then try adding some length to your antenna wire. Experimentation is encouraged!

What if you don't have an antenna analyzer or SWR meter? Another simple device can solve the problem.

Tune for Maximum Brightness or Voltage

While antenna analyzers and SWR meters are convenient and easy, they aren't the only game in town. A very simple device with only a few passive components and a little patience will do the job. That device is called a current transformer, and the phrase "Tune for maximum brightness" once again comes from Peter Parker, VK3YE.

The transformer is made with any toroid you can find (salvaged/unknown toroids are fine) with 1-3 turns of wire on it. The antenna wire is passed through the toroid where it connects to the tuner.

It works on the principle that the more current that is going through the wire, the higher the voltage that is present on the toroid windings. Higher voltage indicates a better match and therefore a better (lower) SWR.

The voltage that comes from the toroid will be at RF frequencies so it can't be read directly by a voltmeter. By rectifying the RF voltage with a small diode, we get measurable DC voltage, which we can measure in any of several ways.

A Toroid, Some Wire, and an LED

One of the simplest ways to both rectify the voltage and measure it is with an LED. LEDs are convenient because not only are they diodes, they get brighter with more voltage—a perfect combination! Put an LED directly across 2-3 turns on the toroid, and put the antenna wire through the toroid. Key up, and check the brightness. Adjust the inductors and capacitor as you would with an SWR meter. The brighter the LED is, the lower the SWR is. Hence the phrase "Tune for maximum brightness."

If you're operating portable, then you may wish to have something a bit easier to read in the sun than a weakly lit LED. Replace the LED with the common 1N4148 or almost any small diode you might salvage out of old electronics. They are easily identified by their glass casing and diminutive size.

Wire the diode in series with 1-3 windings on the toroid. You can measure the resulting voltage with a digital volt meter. Tune for the highest voltage you can, and this will indicate the lowest SWR possible. Using this method, I was able to get an SWR of about 1.2:1.

Building a Simple Meter

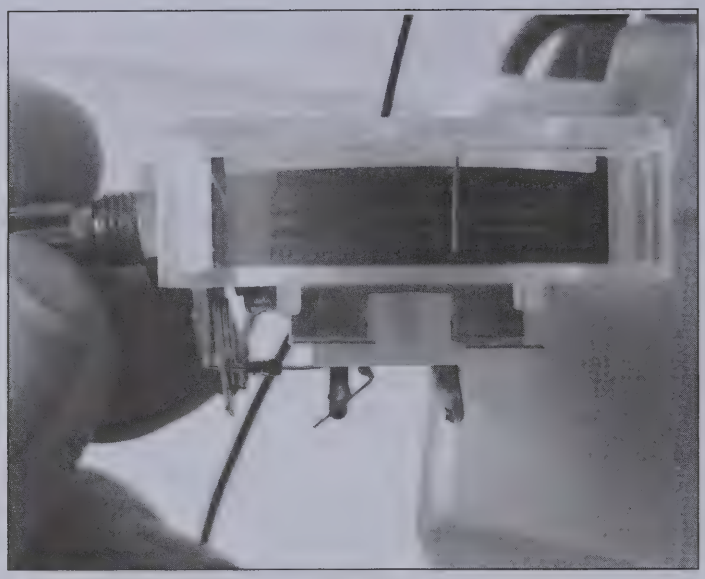
Portable operators might not want to take their DVM along with them every time they go out. In this case a very small dedicated device comes in handy. We will need just a few parts: A meter movement, diode, toroid, and a 5K or 10K potentiometer. The meter movement, diode, and potentiometer can all be salvaged from an old CB radio, and any toroid you find will work.

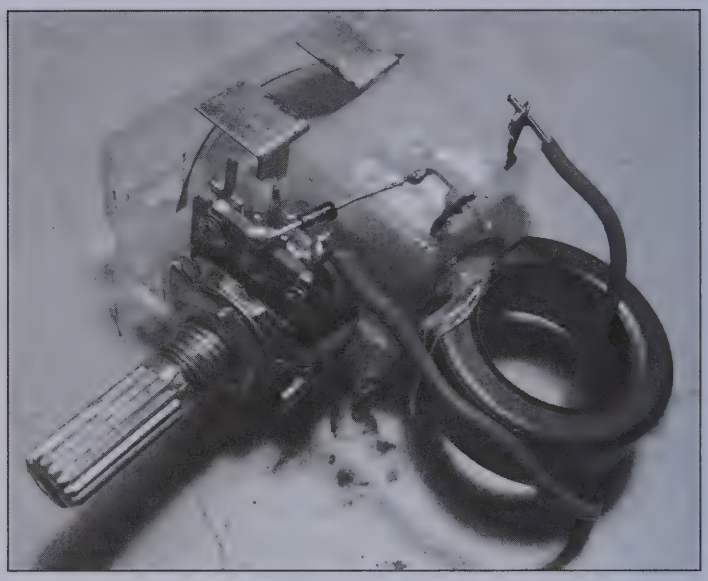
Connect the meter movement in series with a 5K or 10K potentiometer, the diode, and the toroid with one turn through it. The idea is that the meter will be deflected by voltage. The accompanying photos show the wiring and the results:

When you key up for the first time, check to see if the meter needle goes the wrong direction. If so, just reverse the diode. If the needle deflects higher instead of lower when you turn the potentiometer knob to the right, then check that you've connected to the potentiometer as shown in the picture.

Using your Simple Meter

To use your meter, key up and check the needle deflection. Adjust the tuner as previously described. As SWR goes down,





Two views of the simple tune-up meter. A junk box meter indicates the detected voltage.

the needle will deflect further. When the needle reaches the end of its deflection, adjust the potentiometer to a higher resistance to bring the needle back in range. The highest potentiometer setting and needle deflection will indicate highest voltage, and the lowest SWR.

You could even build this circuit with an LED or meter right into your L-match tuner! Add it between the capacitor and the antenna connector with an extra switch to either put it in circuit or bypass it.

Final Thoughts

I hope you've been inspired to build an L-Match tuner and meter for your shack or for portable use. To get the best use out of it, spend the time to put your L-Match tuner in a nice case. It'll be reliable and serve you well for years to come. Constructing your own gear can be a lot of fun. Making your first QSO with equipment that you built yourself is rewarding, too!

For links to all parts mentioned and more pictures, please visit the author's website at https://miscdotgeek.com/qrp-l-match-tuner-build/

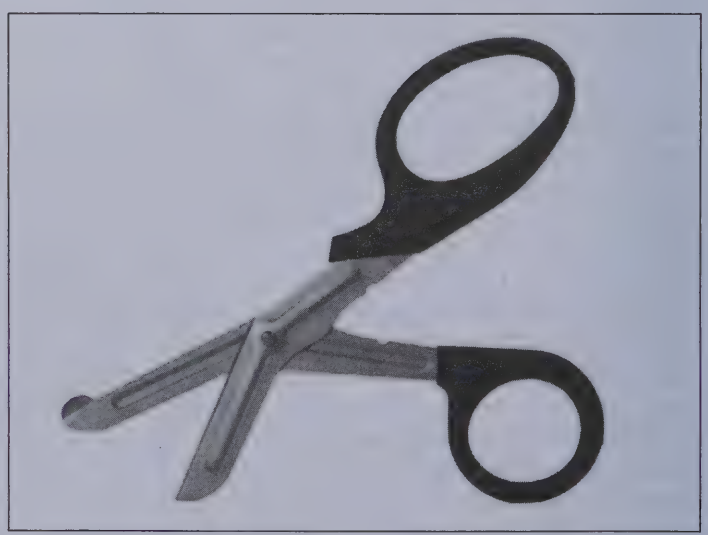
●●

Readers—if you have a fun and useful project like this one, it might make a good article! Just contact the Editor.

QRP Tip from Aaron K5ATG

k5atg.aaron@gmail.com

I stumbled upon this as an experiment and thought I would share it—



A lot of us QRPers have a tendency of using a lot of PCB board form circuit boards to project enclosures. More often than not the size of the PCB board needs to be adjusted for our particular need. Some people use acrylic knives, CNC machines, Dremels, hack saws and the list goes on and on.

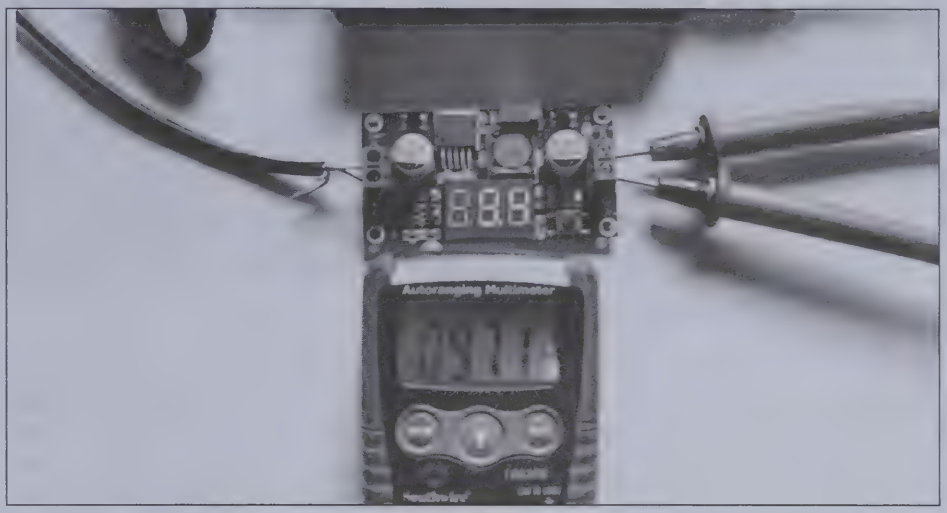
My preferred method is using EMT Shears. I learned all about these shears during my time as a medic. There isn't much that that don't cut through. Their purpose is to cut through seat belts, belts, small wire, clothing, and tons of other products, allowing the EMT to be able to treat the patient.

I recently discovered that they also cut through PCB board with little effort. This is pretty convenient because you don't have to make repeated passes as you would to score it like you would with a knife. You don't need to wear a mask to protect you from the nasty dust created by CNCs and Dremels and such. One of the great things about them is their price. Harbor Freight, and eBay usually have them for less than five bucks and they last for years and years. ●●

LDG Z817 Modifications

John Perkins—KG5HXO

There are a bunch of modifications for the FT817, and not much undiscovered about such a popular rig. There are a lot of ways to power the FT817 and I'm now using—What!—USB batteries. Don't worry I still have some Anderson power poles for 12V, but now I'm using a USB receptacle and cables for 5V as the main power connections. Let me say above 5V is high power and below 5V is low power.



5V to nominal 10V converter.

A Little History

My tuner came with my used FT817ND. I am building a man portable all mode rig and I considered getting a T1. The LDG Z817 is as old as the FT817 design wise but I like it and I like that it has room for modifications.

Not to lose you with my whiz bang ideas, let's look at some RF features of the Z817. The Z817 has UHF connectors on the back. The newer T1 has BNC. As of now I use BNC for 70cm and 2m antennas like my Slim Jim J pole. The Z817 does not tune 70cm or 2m antennas and that's fine with my tuned antennas. Consider that the FT817 has a BNC on the face of the rig, this makes it real handy to use a rubber duck or throw up a J Pole. I added a panel mount PL259 to the front of my Z817 and soldered it to the TX UHF connector on the back of the tuner. So front or rear I have HF hook up as easy as hooking up UHF/VHF antennas to the FT817.

Now that I don't have to access the back of my tuner to hook up my HF antennas I can really shove my radio down in a pack. To get the rig deep and to reduce clutter the first thing I did was use what I had in my tool box. I'm using a right angle PL259 to BNC connector adapter on both the radio and the tuner, with a 6" piece of RG58 instead of a 24" cable with straight PL259 connectors. I ordered some right angle PL259 to RG58 connectors. I plan on building a 6" cable with a straight connector on one end and a right angle on the other. This will connect right angle to the radio and straight to the tuner. Another cable will connect a right to the tuner and a right angle to the antenna.

Now the back of the LDG Z817 is busy. Other than the two UHF connectors you have two 8 pin mini DIN connectors. One connector is labeled "radio" and the other is "computer." The factory connectors are described in the manual with a description to build your own cable. I ordered a Hosa CD control cable which is 3' long and has right angle plugs on each end. I'm using straight connectors on the tuner because there is room and to reduce bends in the cable. Now instead of the LDG 14" cable I have a really short cable. I made a quick cheat sheet for wiring up the Hosa cable to the straight connector. The wiring is pin to pin 1 to 1.

The FT817 / Z817 combination setup. You can see the panel mount SO239 UHF connector and the right angle rear connector.

For rig control I use a BlueCat dongle. I'm still looking or a 38400 baud dongle sold in the USA. I found two places one is ML&S and G4ZLP in Europe and some eBay Hong Kong model. I really like the 817 Companion app which I have installed on all my Android devices.

I gutted the batteries out of the LDG Z817. If your going to use this tuner with a FT 817 I don't know why LDG did not use CAT power to power the tuner. If you look at Pin 2, you will see the output power from the radio. This is what powers the BlueCAT constantly. I have seen some modifications to turn off the power from the CAT or ACC receptacle. For my setup I installed a Drok DC boost transformer in the tuner. Never mind the hack job wires hanging out of the tuner.

I'm still waiting on my Micro USB female connectors and M3 nylon standoffs on the slow boat from China. I'm using some 4-40 bolts and nuts to build the standoffs for now. I milled down a hunk of .250" Plexiglas for the window to the voltage display. The hole with the wires hanging out is to access a push button to toggle the display through three functions input voltage, output voltage or off. This trans-

Front and rear views of the Z817 with modifications.

former is rated for 3 A, well above the 2.4 A input. There is a 6 A model which is a little larger and available with red, blue, or green LED. I would have used the 6 A model with the only downfall it is larger in foot print. The big benefit is better heat dissipation. The other hole is to adjust the output voltage. If you follow along I am using the USB Micro cables plugged into the tuner. The 5V goes to the transformer and then is boosted up to high voltage, normally 9.6V to 10.0V. The high power leaves the transformer and is soldered to some 15 A Anderson power poles. The high power is fed to the radio via a cable I made with an old USB cable with Anderson Power poles on both end. This terminates at my voltage conditioner. I can still use 12V batteries to power the radio. The only power option I lost was the tuner's internal batteries. The USB cable I'm using is a 4 conductor 28 AWG. Since I have power poles on each end I twisted two wires together for each pole. Eventually I expect one of the high quality Anker cables will fail usually at the Micro B connector. I then will cut down that faulty cable and build another Anderson Power Pole patch cable.

So all these tiny wires and 5V batteries still do not feel right. I still have 15A Anderson power poles for 12V after all! The newest PA-48B wall charger replaces the NC-72B. These chargers are rated for 500 mA at 12V or 6 W. Most references to the FT817 will point to 2A current draw @ 12V, or 24 W during transmit. With some old cables I tested this system. I can power the radio and charge the batteries with one cable. I did have the transformer fault out once with an old cable. Never did it fault out with two cables supplying 5V each. I have tested this system with these power sources and a few others. The Anker batteries are rated for 2.4 A at 5V or 12W per a port. The Anker PowerDrive 2 24W 2-Port USB Car Charger—this is not some dime store charger. I use a Anker 40W 5 port wall charger rated for 2.4 A per port as well. We all have ran our FT817 off a 24 W wall charger so running the rig off of two 12W USB ports sounds good. The biggest power concern is the USB connectors. These devices are rated for 5V @ 1.5 A that's 750 mA. I must be punishing my Samsung Galaxy S5 because it charges at 1200 mA ?! ●●

Antenna Throws Using Balloons
John VA3KOT

I use a sand-filled party balloon (about 3-4 ounces). I tie one end of 100 ft of Mason's twine using a simple cow hitch then launch the balloon using a dog ball launcher. It's easy to get the line up 35-40ft which is plenty high enough for the 66ft EFHW sloper I use for field ops. The other end of the Mason's twine is used to pull up the antenna wire.

Use a "Free" Counterpoise for Your Vertical Antenna
Gary K9AY

Sometimes you need a quickly installed antenna! Maybe you're operating Field Day at a vacation spot. Maybe you want to check out a band where you don't have a permanent antenna.

In these situations, I've often used a simple vertical as a temporary antenna. The antenna itself might be a wire hung from a tree limb, supported by a 20-foot telescoping fishing pole, or something more complicated, like several sections of aluminum tubing.

But... verticals need a system of radials or other type of counterpoise "ground" system. Why not use what is readily available? Here are few ideas:

- Metal porch railing, maybe with extra wires clamped onto it.
- Chain link fence
- Aluminum sun porch roof
- Your vehicle or camping trailer

OK, I think you get the idea. One of the best Field Day antennas I ever used was a full-size 40M vertical of aluminum tubing plus wire inside a fishing pole—mounted on the 40-foot long aluminum dock at our lake cabin. In the direction across the lake, it was an amazing performer!

The 1968 Project

Nick Kennedy—WA5BDU kennnick@gmail.com

The 1968 Project: A Classic Direct Conversion Receiver

Back in 1969 in EE School at the University of Arkansas, I wasn't doing much hamming. Too much other stuff going on. And I hadn't developed the competence and confidence needed to become a homebrewer. But I do remember going to a meeting ofthe school's ham club (call: W5YM) where a young fellow was giving a talk about a project in *QST*. I'd been drinking EE theory from the fire hose in my classes and didn't really need more in the form of a hobby. But the guy had an enthusiasm for the project that was contagious.

Being a ham, I knew about mixing ("heterodyning") and stuff and how you take an input signal and mix it down to say 455 kHz and go from there. But this guy was saying, why not mix it all the way down to audio and just amplify it and listen to it from there. Can you just do that? It was an exciting idea. It felt like cheating but also very cool.

So I rushed right out and built one! No I didn't, I waited around for a bit over fifty years and this classic is still talked about and Mr. Hayward has a paper out reminiscing about the project. And I've become a builder and have built lots of stuff.The article gives component values for 80 and 40. I'm doing the 80 meter version here.

The article inspired many other DC (direct conversion) receivers over the decades, especially among QRPers. Consider the HW-7/HW-8, Ten-Tec PM-1 and Century 21, Lewallen's Optimized QRP Transceiver and the famous Neophyte with its NE602 & LM386 lineup. The Pixie II and the Rockmite.

Parts

Can you build this thing without robbing a museum or renting a time machine? Yes! The transistors are silicon NPN so use your 2N2222s, 2N4401s, 2N3904s or similar from your stash. Likewise for the JFET. The MPF102 is still available but you can substitute whatever. W7ZOI suggests PN4416 or J310 for a couple that will work. The toroid types weren't specified back then but we've got some common types nailed down now.

Those 88 mH telephone toroids may be getting a little scarce. You could put in an op-amp based filter but it's nice to stay authentic. Jerry, KI4IO winds the inductor on a bobbin which is inserted into a pot core. So it can be done.

Hi-Z phones are also a thing of the past, but we'll talk about how to use modern ones.

OK, let's talk about the circuit a little. I see it in five stages. I'll mix in some changes I made and problems I had as we go. Figure 1 shows the complete circuit as I built it.

Preselector

First there's a preselector consisting of a resonated three winding transformer shown as L1, L2 and L3. Back in 1968 we hadn't standardized so much on specific core types, but here in the 21st century I'm using T68-2 toroids for this transformer and for the oscillator tank transformer L4/L5. The input and output transformers for the mixer are FT37-43. Anyway, the preselector transformer has 40 turns of #28 enamel on the main (L2) winding while the input and output links L1 and L3 are each 3 turns over the main winding. C1 would be an AM BC 365 pF variable. I think mine maxed at 330 pF.

Next is the product detector a.k.a.

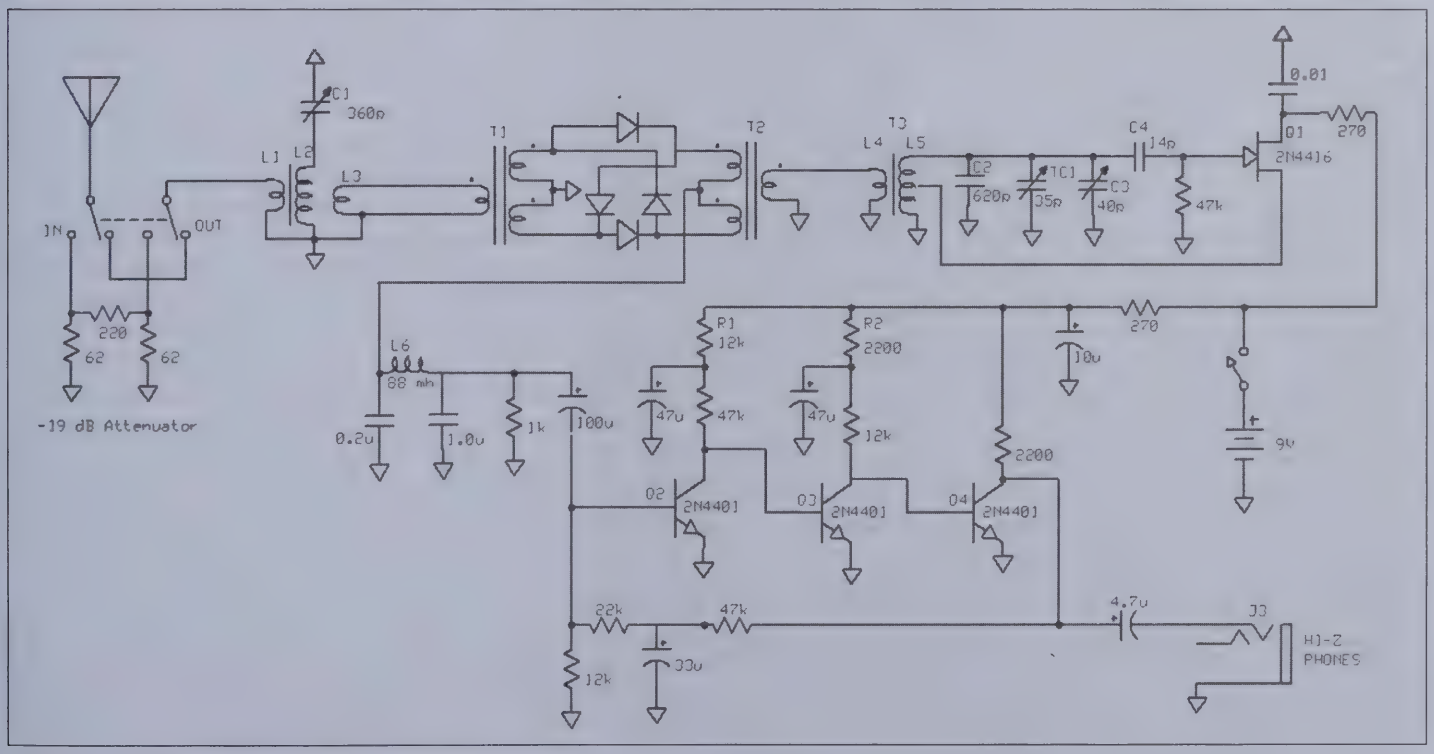


Figure 1—The complete receiver schematic.

Figure 2—Front view of the receiver.

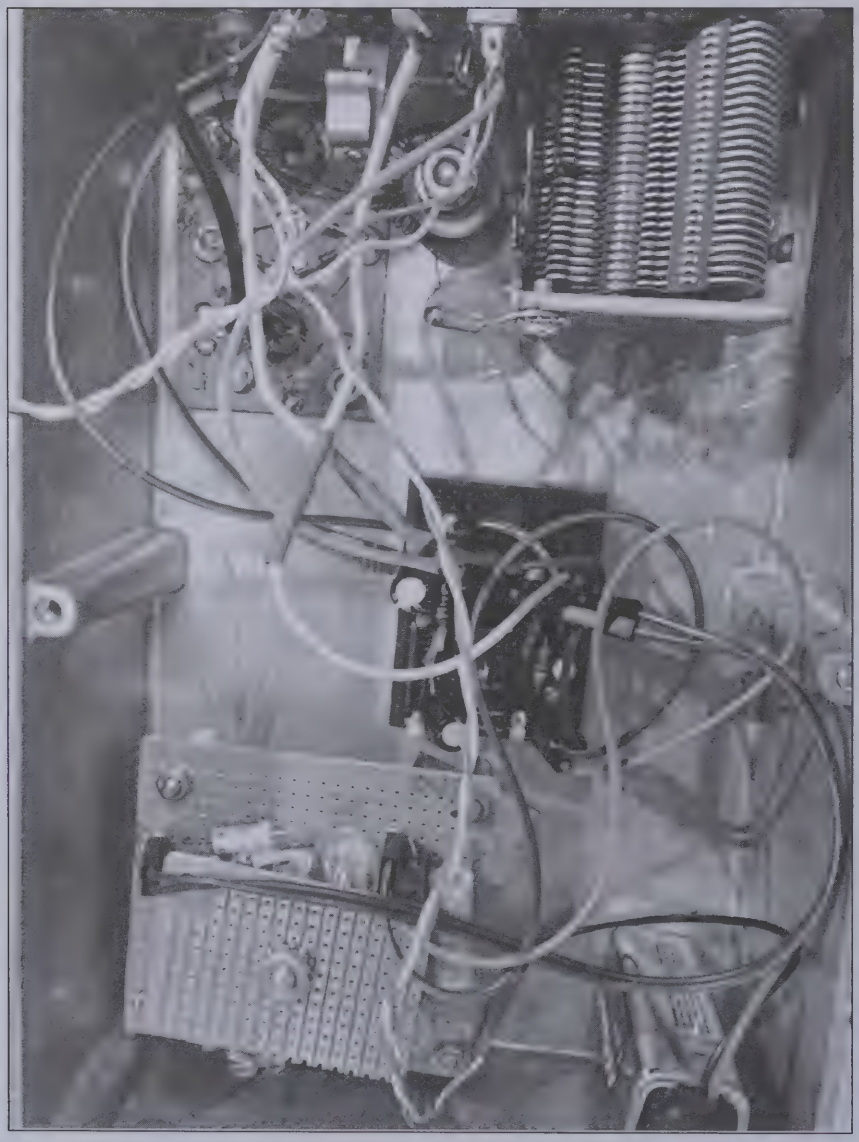


Figure 3—Inside the main box. Top L to R: mixer board, input transformer, preselector variable capacitor. Center: audio amplifier on solderless breadboard Bottom L to R: 88 mH inductor & filter components, 9 volt battery.

mixer, DBM, diode mixer or whatever. I used a DBM kit from Dan's Small Parts. I think it uses the hot carrier diodes but as W7ZOI said in his follow up paper, you could use common small silicon diodes like the 1N914 or 1N4148 too. If I counted right, mine have 11 turns of trifilar wire on the toroids. It's a simple and amazing circuit, but with all those dotted trifilar windings you have to build it carefully. Consulting a book or article showing how it's done is a good idea. Or use a Mini-Circuits packaged unit.

Local Oscillator

As we move left to right we encounter the oscillator. I mentioned that I used a T68-2 for the tank coil's core. The main winding is 22 turns tapped 5 turns from the ground end. The output winding is 5 turns over the main winding. I started with a 2N3819 JFET. The circuit ran when I powered it up but when I terminated it in a 50 ohm load, it stopped—so I switched to a 2N4416. Eventually I saw that either JFET would drive the mixer, it just didn't like the 50 ohm test load for some reason.

I was working in parallel with Jerry KI4IO on this project and comparing notes. Jerry mentioned that C4, which couples the tank to the gate, is pretty large at 680 pF compared with what he's typically seen. I thought OK, but who cares? The gate is high impedance so not much current is going to flow in any case. But on reflection, the signal can get pretty large and forward bias the gate-source junction on peaks and current will flow and load the tank. Maybe that's part of the problem with it not starting into 50 ohms. I replaced that capacitor with a 14 pF silver mica, but I really don't know if it made any difference. It felt right.

Speaking of Jerry's build, he used type 6 toroids for the preselector and oscillator where I used type 2. They both do the job.

The oscillator is simple enough, but there's a lot of room for tweaking to get what you want. The original circuit tuned the 80 meter CW band and most if not all of 75 meters too. The authors reported that they could tune in SSB, but note that they used a vernier drive on the variable. My experience with the NORCAL 40 says a 50 kHz range and one-turn tuning can be OK. Wow, does the phone segment really start at 3600 kHz now? How long did I sleep? Anyway, 100 kHz will be less of a challenge. But I still couldn't tune CW to the pitch I wanted with my arrangement. A big diameter knob helps.

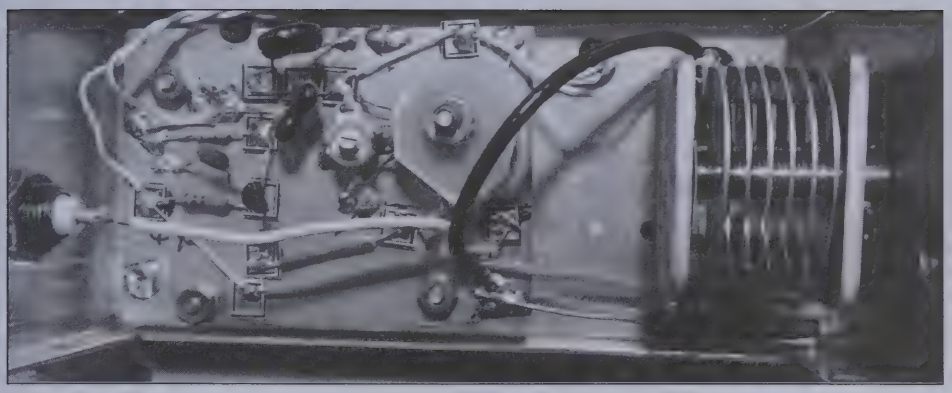


Figure 4—Inside L.O. box.

But I think my variable was a little sticky. I'd started with one of about 150 pF maximum and then put another capacitor in series to cut that down to maybe 40 pF.

Still not smooth enough. At some point in a project you ask yourself if your intent is to just see it work and then put it away, or do you want it to work well? I want it to work well but I'm too lazy to do a lot of rework installing a reduction drive.So I went digging through my junk boxes. I struck gold with a nice little smooth turning variable of about 40 pF maximum and having a built-in 8:1 reduction drive. (Note to self: Look for more of these at hamfests!)

You get into a lot of back and forth trials and calculations trying to hit a desired tuning range. Knowing your inductance, you can calculate the total C for 3500 kHz and for 3600 kHz. My L5 originally measured 3.1 uH and I "back calculated" based on the actual frequency and measured C at 3.045 uH. Not much difference but we're trying to fit into a tight slot.

The capacitance range needed to cover 3500 kHz to 3600 kHz is 36 pF and the variable I found does 8 pF to 42 pF so it's almost there. Close enough. My final component values are as shown on the schematic. Note that I added trimmer TC1, a 10 to 35 pF ceramic NP0 to make it easier to tweak in the bottom or top end, whichever if more important to me. I wound up with 83 kHz tuning range and chose to set the bottom at 3500 kHz.

You can see in the photo that I have a dial pointer and crude paper scale to give me a reasonably good indication of frequency. My hamfest buy variable capacitor had this pointer already crafted by the previous owner. He slipped a grommet that fit snugly on the shaft onto it. Then he bent a U-shape at one end of a fairly stiff wire for a pointer and slipped that onto the grommet. Pretty clever.

My little box had an unused BNC at the back end so I wired that to the LO output. Now I can easily check that my pointer hasn't slipped by hooking up a counter.

In casual use, the local oscillator seems plenty stable. I'm showing 1.1 Vpp out to the mixer.

Audio Filter

Following the audio output from the product detector is a 3-element lowpass filter with capacitor shunt elements and an 88 mH telephone toroid as the series element. I actually had one and it measured 79.6 mH. We don't know what the desired response was but the intent was to be able to copy SSB as well as CW. Using my oscilloscope to view amplitude versus frequency I saw that my peak was above 2000 Hz. I wanted to lower that quite a bit to emphasize CW. In LTspice, I saw a peak at 2200 Hz, a saddle shape below that with 700 Hz being 8 dB below the peak, then a smaller peak at 250 Hz and rolling off below that.

I looked at how to emphasize the lower range over the high. The result is seen in my schematic.

I experimentally bumped up the 0.1 uF input to the filter to 0.2 uF and the 0.47 uF output filter to 0.94 uF (two 0.47 uF in parallel) and dropped the roll-off point down another 300 Hz.

In the interest of bringing up the lower part of the audio range, I changed the 5 uF capacitor between the filter and Q2 to 100 uF. For the same reason, I changed the 3.3 uF in the feedback loop to 33 uF. This negative feedback path is mostly for DC, but if that capacitor doesn't bypass the lows sufficiently they create negative feedback for the lower range.

Audio Amplifier

Over a hundred dB of stable gain with three transistors. At first glance you might think it's some kind archaic design with its directly grounded emitters and directly coupled outputs. But not really. There's a similar amplifier and audio filter in *Solid State Design for the Radio Amateur* (SSDRA). See chapter 5 figures 11 & 12. *The Art of Electronics* book cautions against using no emitter degeneration in general due to concerns about distortion, but if you need a bunch of gain it's a method that can do the job. Gain in a common emitter amplifier is Rc/Re, where Re in this case is just re, the intrinsic emitter resistance, which equals 25/Ie with Ie in mA.

From LTspice, the gains of the three stages are 54.4 (35 dB), 69.4 (37 dB) and 63.8 (36 dB) for a total gain of 240,860 or 108 dB. That can actually be a bit too much with strong signals and no volume control. Another interesting feature in this amplifier is the DC feedback to center the output stage voltage at about half of the supply voltage.

Since the output stage uses a 2200 ohm resistor in the collector lead, that's your output impedance and so Hi-Z headphones of the 2,000 ohm variety are called for.

Building and Boxing

Figure 4 shows the inside of the L.O. (local oscillator) box and Figure 3 shows the inside of the "everything else" box.

There are several building techniques you can use and I just about used them all. My product detector and oscillator each have their own Manhattan style boards. The filter is built on a piece of perf board with the big toroid sandwiched between two pieces and the audio amplifier uses a solderless type breadboard.

The experts advise us to shield the local oscillator by placing it in a separate box. For once I've followed their advice and put the oscillator in a small aluminum box, which is mounted on a larger box containing everything else. The larger box is a battle scarred cast aluminum hamfest find. Rather than use connectors in and out, I drilled holes through the floor of the oscillator box and the lid of the larger box to pass RF and battery wires through. I left

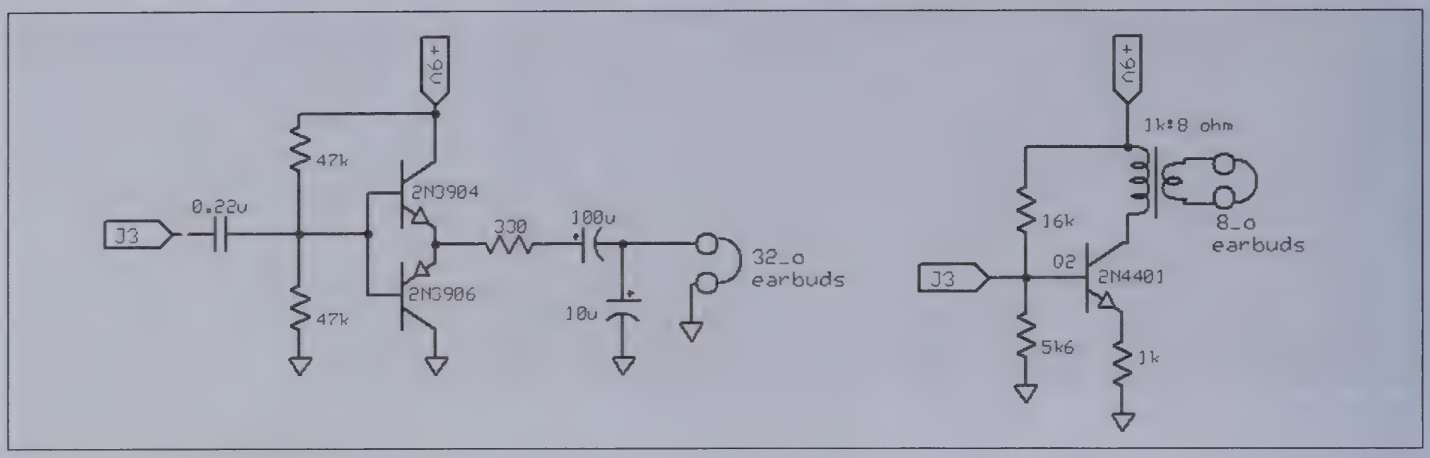


Figure 5—Audio amplifiers for Lo-Z phones.

enough slack that I can flip the lid of the bottom box while everything stays connected.

I added a low current LED to remind me to switch off the power, since my battery is internal and will requireremoving some screws to replace.

Driving Modern Low-Z Phones

I wanted to keep the basic receiver authentic, including its Hi-Z output. I have two sets of those old phones that worked fine. But I also wanted an interface to my favorite modern earphones or earbuds.

My first solution was the obvious one: Use an audio transformer. I had a miniature Radio Shack 8 to 1000 ohm part to try. But to my surprise, it caused motorboating in the audio amplifier. Rather than try to run this mystery to ground, I decided to go with an active interface.

Keeping that notion of authenticity in mind, I wanted no power gain, no LM386, just the ability to drive the same power to a 16 or 32 ohm load. Authenticity aside, there's plenty of power in the existing circuit and it would be easy to over drive an external amplifier.

It's not as easy as I might have thought to drive earbuds with a single transistor or BJT. An emitter follower for example is a good choice but would use more standing current than I wanted to spend. So my first version went the easy way with a TS922 dual op-amp, one stage driving each earbud. This worked OK and only drew 2.57 mA, but I wanted something simpler.

I went back to the emitter follower but this time using a miniature 8 to 1000 ohm transformer. After moving the transformer from the emitter to the collector lead, I was pleased to get resting current to 1.5 mA. This worked well but I'd rather not require the transformer. This is shown as "method 1" of Figure 5.

How to get to low impedance without a transformer and with low current? How about a PNP/NPN pair in a push-pull type of circuit. I borrowed the sidetone amplifier from Wes Hayward's Universal QRP Transmitter of the April 2006 *QST*. It's very simple and draws less than 0.1 mA idling current. The schematic is shown as "method 2" of Figure 5.

I even tried connecting earbuds directly with no driver, although I had to add 1,000 ohms in series to keep the amplifier from motorboating. It worked surprisingly well despite the big mismatch loss—I could even hear a 1 uV signal at the antenna. This is all due to the high gain of the audio amplifier and the great sensitivity of some modern earbuds. I'm using "The Plug" from Koss.

Note that earbuds are typically 16 ohms each and you can connect them in series for 32 ohms or parallel for 8 ohms. I connected in series except when using the transformer or the op-amps.

The wide frequency response of these modern earbuds can be a disadvantage in this context with lots of hiss coming through. With a couple of the amplifiers I tried, I found that 10 uF across the output helped a lot.

Performance

It sounds pretty nice. It tunes smoothly, as I said. The quality of the sound may be dependent on the condition of the funky old 50 to 70 year old Hi-Z phones you're able to dig out. Or go with one of the Lo-Z options.

Another thing is that a strong signal, say just a few dB over S-9, can overdrive the audio amplifier causing distortion. The original article suggests simply detuning the preselector to attenuate the signal. That does work, but I added a switchable 19 dB attenuator to the front end. It helps a lot.

For current draw, I measured 7.8 mA with no signal and 7.8 mA with a loud signal,using a new 9 V battery.

There's something to say for what you don't hear as well. I'm not hearing any broadcast stations or other out of band stuff breaking through.

As a final experiment I adjusted the frequency trimmer so I could hear the low end of 75 meters and listened to a bit of SSB. It sounded OK but no doubt my changes to the audio filter had some negative effects on the fidelity.

Here's how Wes Hayward described Doug DeMaw's reaction when evaluating the receiver at ARRL HQ in 1968:

"The signal was clean. Peaking the antenna trimmer changed the amplitude, but nothing more. There was no interaction between controls. When another CW signal appeared in the passband, both could be copied. Tuning was smooth, almost textbook in character."

References

1) "Direct Conversion, A Neglected Technique," by Wes Hayward W7ZOI and Dick Bingham W7WKR, *QST,* November 1968.

2) "Direct Conversion Receivers—Some Amateur Radio History," by Wes Hayward W7ZOI, published online in PDF form. ●●

An Arduino Based 63 dB Step Attenuator

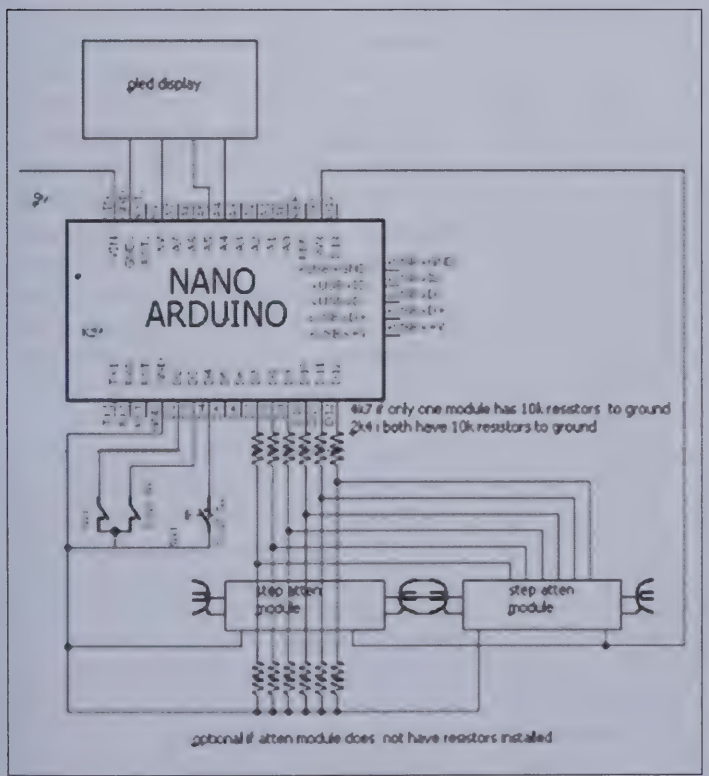
DuWayne Schmidlkofer—KV4QB kv4qb.blogspot.com

I usually use fixed attenuators when checking gain and linearity of amplifiers. But when I was calibrating a couple power meters, this became a very tedious process. I guess it is time to build a step attenuator. Looking around I found several examples using DPDT toggle switches and precision resistors. I also found some information on digital attenuator ICs, that looked very interesting.

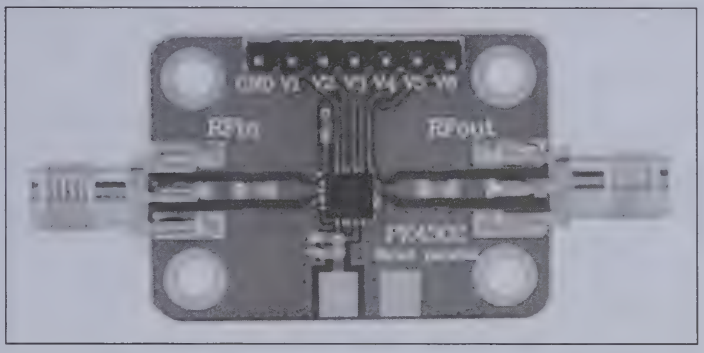
On several sites I found some attenuator modules that gave up to 31.5 dB. attenuation in 0.5 dB. steps. These can be controlled with simple switches, but I decided to use an Arduino with a rotary encoder and OLED display. I wanted more than 32 dB, so I decided to put two of these modules in series and wire the control lines in parallel. I did not have a need for 0.5 dB steps, so I only used 6 control lines to give a total to 63 dB. in 1 dB. steps.

The Arduino, encoder, display "Building Block" is basically the same as I used for several other projects, including a SI5351 VFO. I had several spare circuit boards I had made for the VFO, and decided t use that for the prototype. I had designed it with some additional output pin brought out. The only thing that would complicate the wiring was that the module uses 3.3 volt and the Nano was 5 volt. The Nano has a 3.3 volt output, and checking current requirements of the modules it will supply enough current. Simple voltage dividers will take care of the control lines. The modules had pull down resistors installed on the control pins, so I only had to add series resistors going to the Nano pins.

The attenuator modules come with female SMA connectors. I replaced one of them with a male connector so I could connect them directly together without having to use a short cable. This



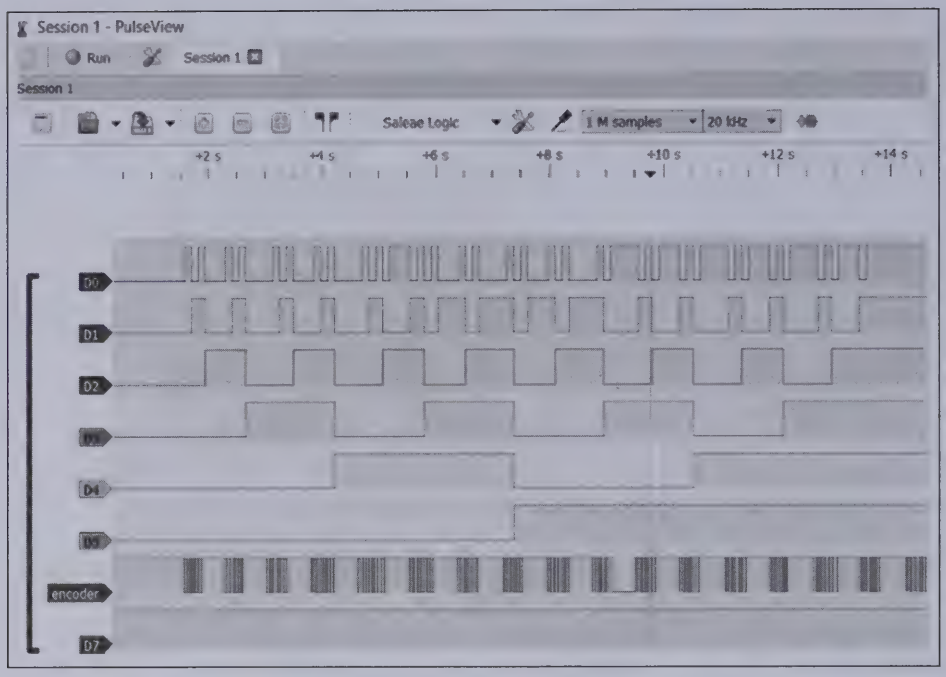
Block diagram of the attenuator and controller.



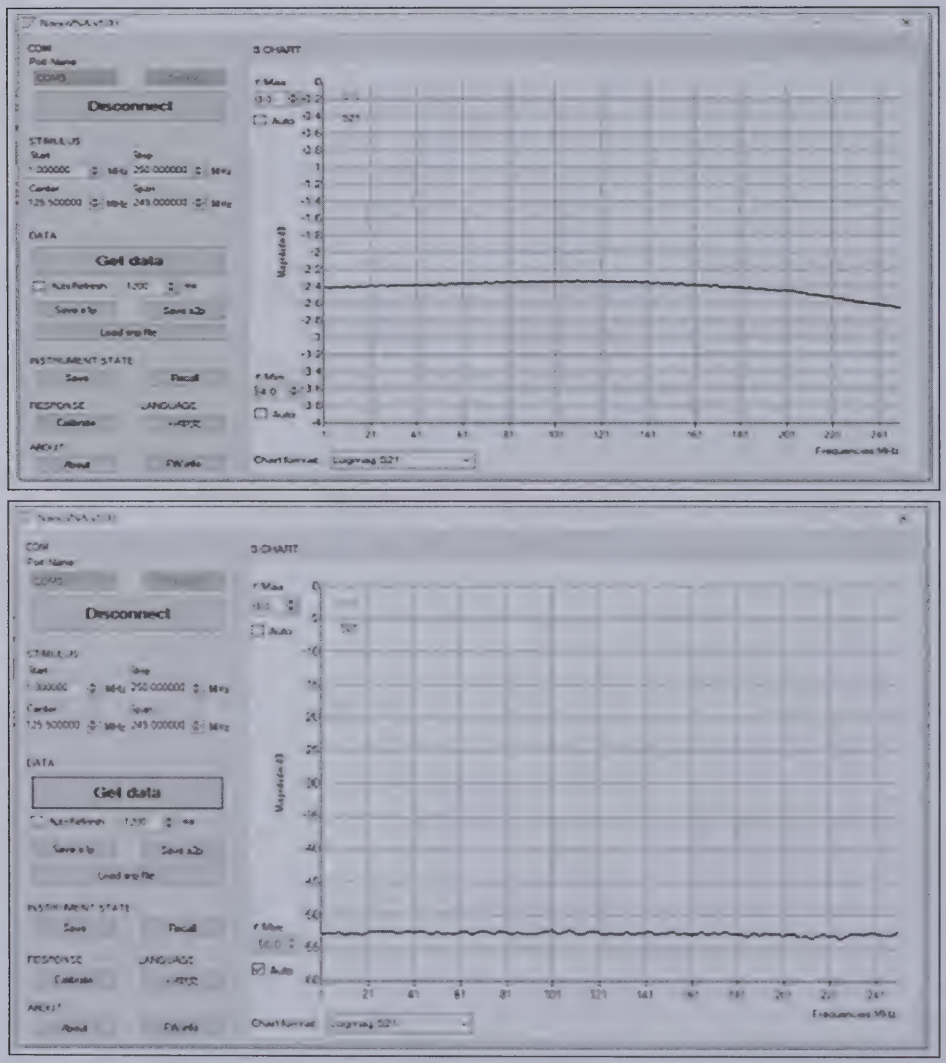
31.5 dB, 0.5 dB step attenuator module.

```
void setAtten() {
  int atten = AttenValue;
  if (atten >= 32) {
    digitalWrite(DB_32, HIGH);
    atten = atten - 32;
  }
  else  digitalWrite(DB_32, LOW);
  if (atten >= 16) {
    digitalWrite(DB_16, HIGH);
    atten = atten - 16;
  }
  else  digitalWrite(DB_16, LOW);
  if (atten >= 8) {
    digitalWrite(DB_8, HIGH);
    atten = atten - 8;
  }
  else  digitalWrite(DB_8, LOW);
  if (atten >= 4) {
    digitalWrite(DB_4, HIGH);
    atten = atten - 4;
  }
  else  digitalWrite(DB_4, LOW);
  if (atten >= 2) {
    digitalWrite(DB_2, HIGH);
    atten = atten - 2;
  }
  else  digitalWrite(DB_2, LOW);
  if (atten >= 1) digitalWrite(DB_1, HIGH);
  else  digitalWrite(DB_1, LOW);
}
```

Arduino programming code.



Logic analyzer display.



VNA plots of attenuator performance.

also made it easier to do the board and case design. I added some header pins to the power connectors on the two attenuator modules. This way I can just plug them into header sockets mounted to the back of the controller board when I design a dedicated board.

After building the board I worked on the software. It is very simple, with just checking the rotary encoder and incrementing or decrementing the attenuation value by the step size which can be changed by pressing the encoder button. If there is an encoder event, the attenuator control lines are set to the correct value. The code to set the attenuator is very similar to what I have used in the past for a successive-approximation ADC.

To check the proper logic I used to set these lines, I used a little $10 eight channel USB logic analyzer I picked up on eBay. The first logic analyzer I used was abound 1980, and was a 16 channels unit and cost several thousand dollars. At that time the software in the unit was very basic, with only simple trigger options. The little USB unit uses a open source program called Sigrok PulseView. It is also a fairly basic program, with similar trigger options to the one I used before. But, it also has several advanced functions such as being able to decode I^2C, serial, and other data streams to the binary,hex, or ASCII values sent or received.

I connected the logic analyzer to the 6 control lines going to the attenuator modules and another line to one of the rotary encoder pins. As I turned the rotary encoder I captured the logic levels on all the connected pins. The results are shown in this diagram. With the delay I have between value changes, I was not able to get smooth continuations change in values. But each turn of the rotary encoder produced the proper logic level changes to the attenuator modules.

I have been using 9 volt batteries for powering most of the smaller projects, and usually use a rechargeable battery. This has meant that I have to remove the back cover from the unit to change the battery. I recently found some 9V batteries that have a built in charge controller, and can be recharged through a Micro USB connector mounted on the bottom of the battery. This has made it possible to just include an access hole on the case to allow connecting of the USB cable for recharging. They cost

The completed attenuator system.

a little more than the rechargeable batteries I have been using, but the convenience makes up for the slight difference.

When I was happy with the final design of the printed case, I added some laser print decals. I also painted the inside of the case and bottom cover with several coats of an acrylic paint that contains some actual powered copper. Have not checked, but hope this will provide a little additional shielding to help reduce any radiated signal.

I measured insertion loss with the unit set to 0 dB, and found about a 2.5 dB loss with a VSWR between 1.05 and 1.1, at all frequencies up to over 220 MHz.

I also measured the attenuation levels at various values and found it to be within 1 dB. at any value across the frequency range.

After using it for a while I make a change to the software. I decided to use a long press on the encoder to toggle the display from actual attenuation to a "relative" value without the added insertion loss of the attenuator modules. This makes it easier for some gain measurements.

Anyone interested in building one of these, the circuit board, and software are available through links on my blog kv4qb.blogspot.com.

●●

A Simple RF AGC

Don Cantrell—ND6T www.nd6t.com

Those fun little receivers that we build certainly don't lack sensitivity. They can hear most everything that the big store-bought rigs do. It can be annoying, however, when some nearby and surprisingly strong station transmits on frequency. Especially during a net or round-table. I cannot reach the RF gain control fast enough to spare my ears.

Most AGC circuits control the receiver's RF amplifier gain, but most of our simple receivers don't have (or need) that amplifier section. Controlling the audio gain is usually the solution but it is limited as to dynamic range and it only adds to the overload distortion of the rest of the receiver when faced with an overwhelming signal.

These problems are much more evident when operating SSB. Most CW operators don't use AGC since any strong signal near the operating frequency will "pump" the gain and disturb the weak signal that you are attempting to hear. Try listening to SSB or a broadcast station and you soon miss the automatic signal leveling. It's rather nice to walk about the shack with the receiver on speaker and not have it blast the household intermittently.

My first experiments used a simple MOSFET as a shunt from the output of the RF gain control to ground. That worked nicely but only exhibited a 20 dB range. Very importantly, there was no measurable insertion loss when the AGC was off, so weak signal reception was not affected.

My breakthrough was when I extended the circuit to include a series element. The two transistors worked as a team to provide an RF attenuator circuit with a nice gradual response over a more than 50 dB range (at 4 MHz, 34 dB at 30 MHz). Insertion loss was a mere 0.6 dB when the AGC was off. Much better than the 4.5 dB minimum of a PIN diode array.

When idle, the series transistor is biased into full conduction with the source at zero volts and the gate at 2.5 volts. The shunt transistor is biased to full cutoff with both the source and gate at zero (ground) potential. Notice that there is no bias voltage on the drain of either of those transistors? Not needed! One of the useful properties of MOSFET devices is that the conduction of the source-to-drain silicon is solely controlled by the source-to-gate potential. Don't you wish vacuum tubes would do that? As a matter of fact, it's a good idea in this case to place blocking capacitors at the input and output of the RF path to prevent any unwanted DC from your particular receiver.

Signal level detection for this circuit is derived from the input to the audio (volume) gain control. Not the output (wiper). This way the circuit will be always ignore the volume control setting and just use the available receiver gain. That audio signal is then amplified by a simple one-stage bipolar transistor amplifier, rectified by the two diodes to create a DC control voltage, and applied to the variable RF attenuator. An S-meter can be easily implemented using this same voltage.

Circuit Description

Low level audio signal from the input of the volume control is fed to a single stage audio amplifier through L1 which serves as a low-pass filter to reduce any RF pickup. Q1, C1, R1, R2, and C3 form a minimalist audio amplifier. Any general purpose NPN transistor with decent gain can be used.

The output of the amplifier is applied to diodes D1 and D2 for rectification and the resultant voltage is filtered by capacitor C4 as the AGC control voltage and for use as an S-meter signal source. This voltage will vary between zero and 2.5 volts depending upon input signal level.

Power is supplied from a +5 volt source. Often the existing radio design will

include one, especially if there is a digital component like a synthesizer or display. The current drain is negligible. Capacitor C2 provides bypassing and a bit of filtering before providing voltage to the amplifier and the voltage divider R3, R4. The divider sources a 2.5 volt bias to the gate terminal of Q2, the series element of the attenuator.

The AGC control voltage is applied directly to the gate of Q3 and, through R5, to the source terminal of Q2. When the received signal is low or non-existent the AGC control voltage will be zero. With no potential between source and gate, Q3 will be cut off and appear as an open shunt to the incoming RF. The series element (Q2) however, will then have a 2.5 volt differential between source and gate and so will be fully turned on and passing RF through with very little loss to the RF output terminal.

As input signal level increases, so does the AGC control voltage. Q3 gradually begins to conduct, shunting more signal to ground and Q2 begins to act more like a resistor, dropping the RF even more. When the control voltage reaches 2.5 volts Q3 reaches full conduction (about 5 ohms) while Q2 is well into cutoff and acts like an open circuit.

Resistors R6 and R7 form a discharge path for C4. Although C4 charges quickly, providing a fast response to a loud signal, it discharges through those resistors at a slow rate, holding the attenuation on for a while before gradually tapering off. This is called "fast attack, slow release". The discharge rate is a compromise between having the signal level restored too quickly (resulting in "pumping" or oscillation) and too slowly (causing weak signals to be attenuated too much following a strong signal. A single 1 megohm resistor can be substituted here but shown is a switch that can give the operator some control.

I use a front panel mounted three position double throw single pole (ON-OFF-ON) toggle switch with the two resistors mounted upon it. With the switch in the "OFF" position the AGC control voltage is grounded and the AGC is off. Great for CW work. When in the "SLOW" position the switch is open and CW discharges slowly through both R6 and R7. In the "FAST" position the discharge is only through R8 and is much quicker.

I tie my S-meter to "OFF" terminal of the switch. Since these rigs use an Arduino digital board for control I use one of the Analog to Digital inputs and a small subroutine to calculate the correlation of AGC voltage to S-meter reading and to display that on my digital display.

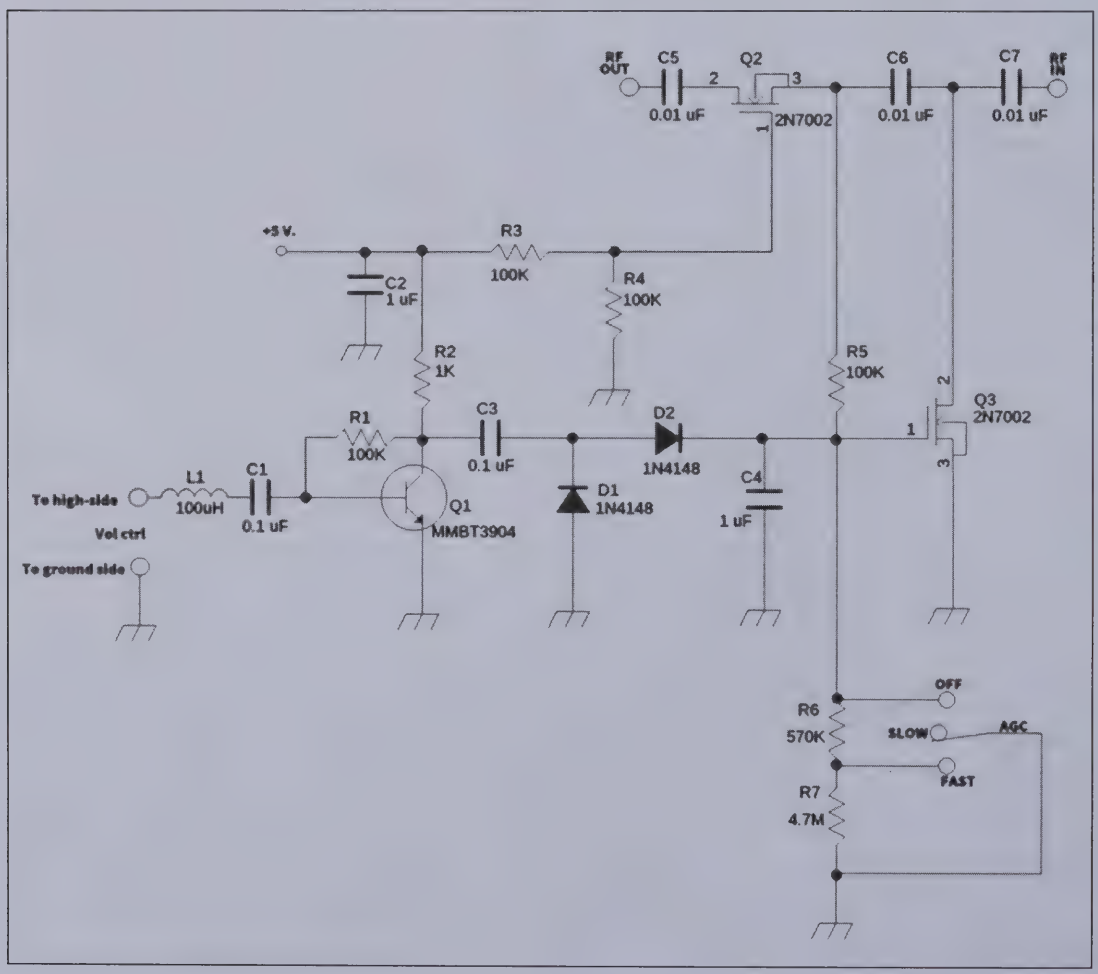
Construction

I prefer surface mount construction since it is easier for me and will fit in a small area. If you are building where space is not an issue or if you are not comfortable with working with these small parts then you will find that it works just as well with the big components with wire leads on them. Q1 can be a 2N3904 or a 2N2222. Q2 and Q3 can be 2N7000, or BS170.

My versions of this circuit were used in BITX40s and uBITX transceivers. The construction and installation examples can be found on my web site at: http://www.nd6t.com/uBITX/AGC. I use it in conjunction with a simple potentiometer RF Gain control. In order to keep leads short and installation simple, I build this circuit on a small board that mount on the back of that control. Some builders (and at least one kit maker) choose to build it as a daughter board that mounts atop the main RF printed circuit board and taps into the receive-only RF path at that point.

On the BITX transceivers, the AGC begins to limit the signal at about S8 or S9 and provides a nice control up to about S9+40 or +50 dB level before the speaker volume becomes louder. Not bad for such a simple and easy modification.

—de ND6T



Schematic diagram for the simple RF AGC circuit.

A Remotely Switched Antenna Coupler

Jerry Wolczanski—KI4IO alphak4ja@gmail.com

This paper describes a remotely switched antenna coupler used to match my inverted-L antenna. The coupler uses simple wireless devices that operate in the 433 MHz amateur radio band. These inexpensive devices have SPDT relays which I use to turn on DPDT relays which switch in/out fixed LC components to effect a match on multiple bands. Important to note that this is not an "auto tuner" but a fixed antenna coupler using predetermined matching components. My original remotely switched coupler used a motorized switch. This describes "version 2" that uses wireless devices.

The Antenna

I'd like to start out by describing my antenna. I built a 160-meter add-on kit for my K2 and needed a 160m antenna. Where else to look for expertise on 160 but the archives of W1BB, Stew Perry (SK). Possibly his favorite antenna was a 165' long inverted-L described in this link:

http://lists.contesting.com/_topband/2001-10/msg00197.html. Why such an odd length? The *ARRL Antenna Book* shows a chart (below) which describes Radiation Resistance vs. Length (in degrees, 90 degrees being a 1/4 wave, etc.). See Figure 1.

Typically, we're looking for 50 ohms and you can see here that an antenna that is a little longer than 100 degrees. gives a Radiation Resistance of 50 ohms.

50 ohms—that's the good news! The bad news, there's some reactance. See the chart in Figure 2.

So, at an antenna length of about 100 degrees, there is some inductive reactance of about 100 ohms. This can be canceled out with a series capacitor of ~880 pF on 160 meters.

That reactance vs. antenna height (length) chart is accurate for antennas which have a length-to-diameter ratio of about 2,000. My 165' inverted-L, with #14 wire has an L/D ratio of about 31,000:1! No worries! We'll just stick a variable capacitor in the coax lead, tune for minimum SWR and measure the capacitance value with my nifty AADE LC meter.

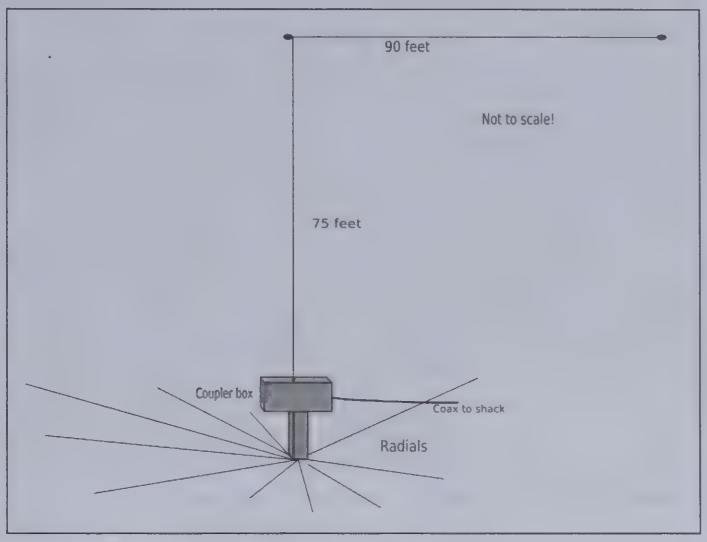


Figure 3—My inverted-L antenna.

My Inverted-L

So I sat at the base of the antenna (Figure 3) with a my K2, a home-brew antenna coupler and a battery. I tuned the antenna on 160 meters with a big air variable capacitor. It needed 326 pF to obtain a near perfect match on 1810 kHz, not the 880 pF from the chart. But, that chart does not consider ground losses which are essentially in series with the radiation R. My test set-up is shown in Figure 4.

I used my AADE meter to carefully measure the L and C values for 160, 80, 40, and 30 meters. I then used a salvaged motor-

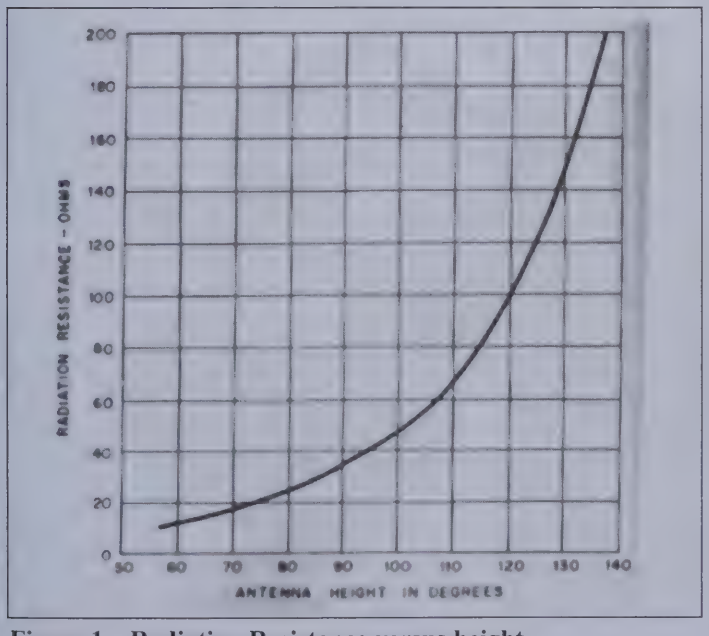


Figure 1—Radiation Resistance versus height.

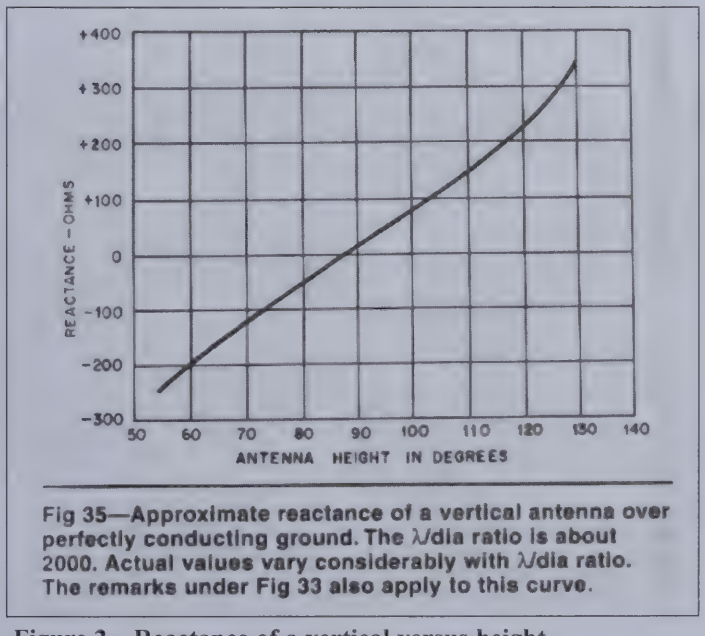


Fig 35—Approximate reactance of a vertical antenna over perfectly conducting ground. The λ/dia ratio is about 2000. Actual values vary considerably with λ/dia ratio. The remarks under Fig 33 also apply to this curve.

Figure 2—Reactance of a vertical versus height.

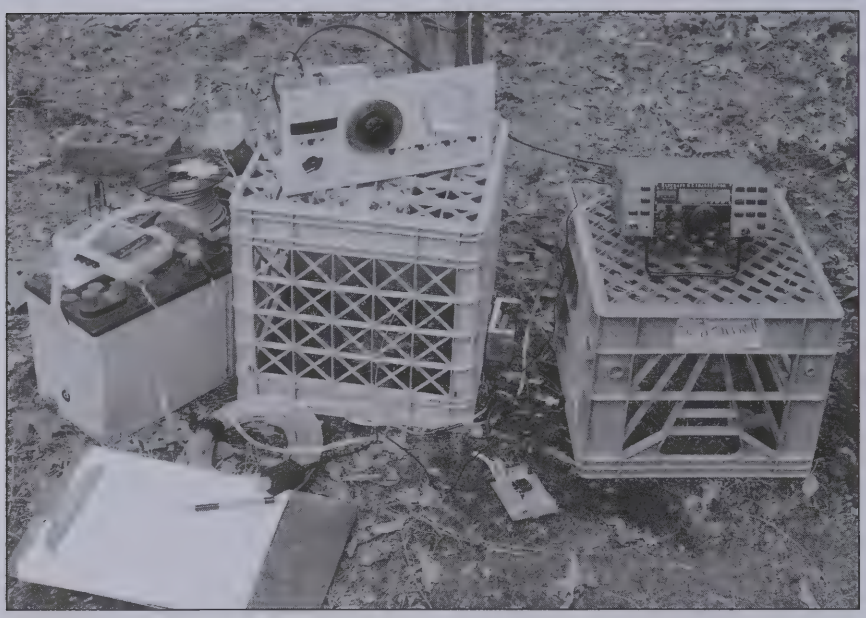


Figure 4—Measuremenets were made with test gear at the base of the antenna.

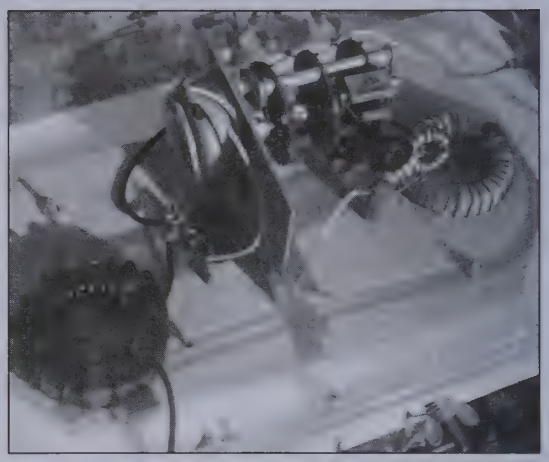


Figure 5—The first attempt: a motorized switch version.

ized DC switch (with a bias-tee for power) and built a switched tuning network. Figure 5 shows what it looked like (each band had its own LC combo).

The big toroid was a common-mode choke. When it worked, it was wonderful, but the motor was balky and I cussed at it for almost an entire year.

I managed 143 contacts in the Dec 2019 Stew Perry event on 160. That included more than a dozen DX stations—that was with 10 watts (I forgot to turn my power down to 5 watts and could not list myself in the QRP category. Geeze.

But that blasted switch, sometimes it worked and sometimes it didn't. I never could figure out why.

Enter eMylo!

Googling "remote switch" sent me down some very expensive alleyways. But then I found eMylo and bought a DC 12V 6x1 channel RF wireless remote 433 MHz for a mere $34. It consists of two hand-held transmitters, and in my case, six little receive modules. See Figure 6 below.

Yep, they operate in the 433 MHz band! On the receive module, the little coil of wire is the antenna. The blue cube is the relay (SPDT) and the power connections from Left to Right are: 1) NC relay contact. 2) Common. 3) NO relay contact. 4) +12 VDC. 5) -12 VDC

To nanoVNA or not to nanoVNA?

In the meantime, I got a new nanoVNA, fresh from Wuhan, China. Could I measure the impedance of my inverted-L? I could then plug those numbers into an L-network calculator and not have to drag my ham gear out into the backyard! I already had a set of LC numbers but I had a less-than-perfect match on a few bands.

The nanoVNA numbers jumped around horribly. At least two of my ham friends suggested possible interference from my local 22 kW AM BC station, a mere 3 km

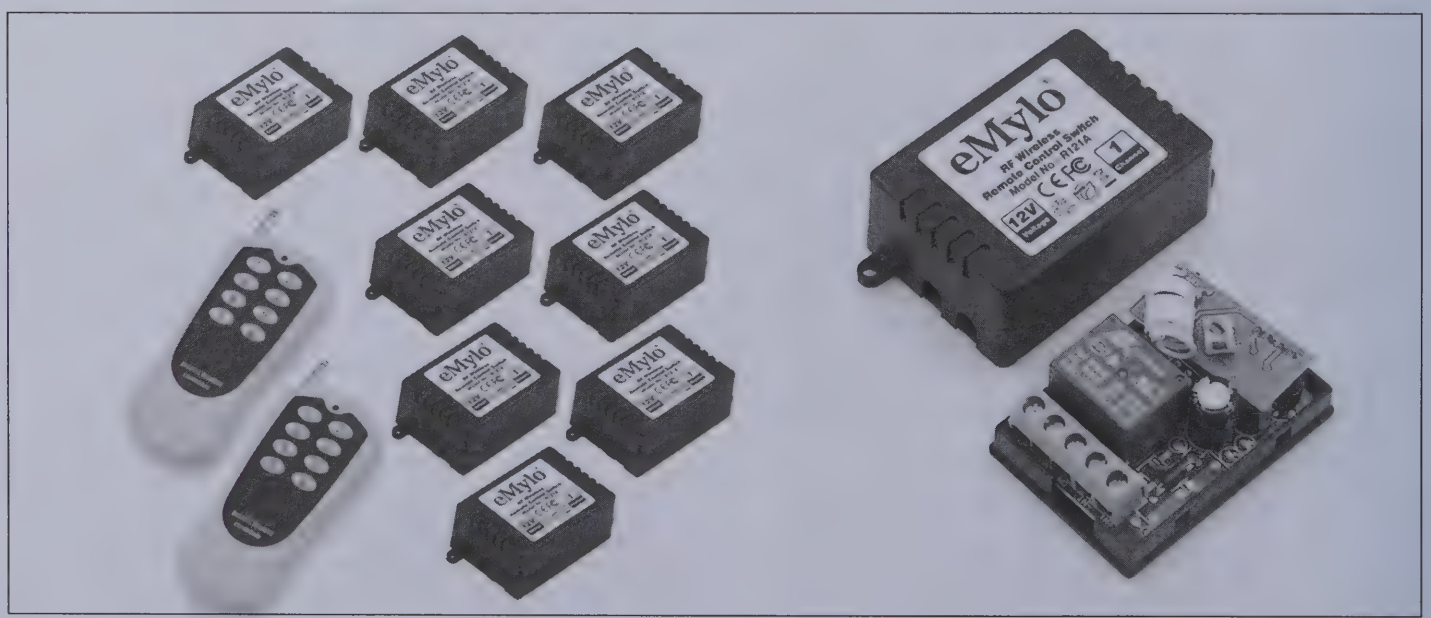


Figure 6—The eMylo set of wireless remote switch modules.

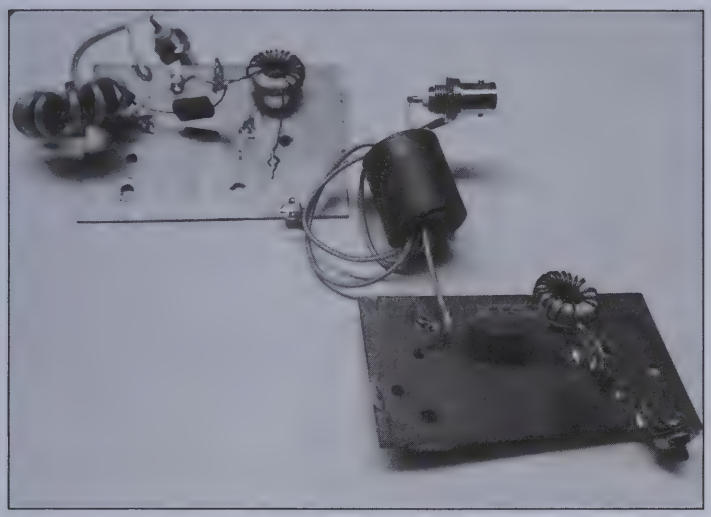


Figure 7—The two test matching networks.

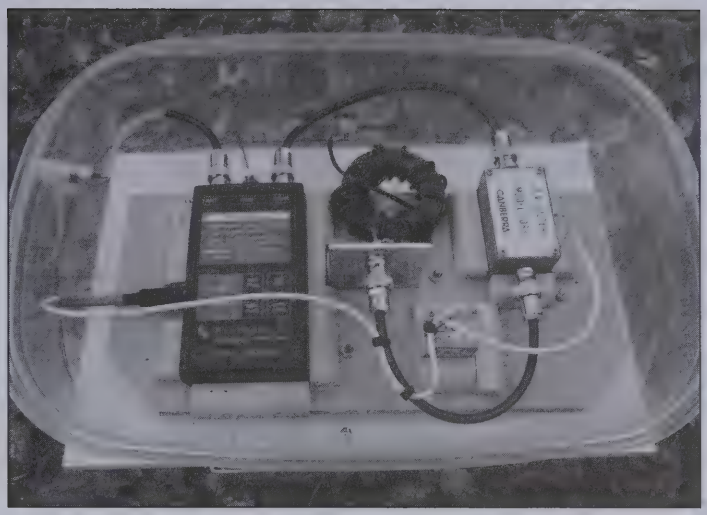


Figure 8—Tried the Elecraft T1. It didn't work on 80/160.

from my house. So I went out into the backyard at night, when the BC station switched to night-time power (60 Watts). The nanoVNA was steady. I plugged the readings into an on-line L-network calculator, but now I was like the man with two watches.

My actual measurements of coupler L and C values on 40 meters (taken twice) were:

1.668uH and 167 pF
1.642uH and 170 pF

The numbers from an on-line calculator (from nanoVNA antenna measurements) suggested: 1.56uH and 196 pf.

So I built two (dueling!) matching networks based on the two conflicting L & C measurements (Figure 7)

I always have the inductor as the shunt element as it gives me some protection from my AM BC station (high-pass). I put a common-mode choke in both LC networks.

The LC network derived from antenna coupler component measurements was the clear winner. I was able to "tune" the LC combo by spreading or compressing the toroid turns and observing the impedance on the VNA.

So, the nanoVNA worked, but not when trying to ascertain the impedance of the 165' wire and ground.

So, with LC data in hand I opted to construct a remotely switched coupler for 160, 80, 40, 30, and 20 meters. Position #1 I would use for "straight-through" operation (no LC components). I could use that for my NDB beacon SWL station.

I planned on using the same "Tupperware" box that housed the motorized switch version.

BTW, I also built and used a Elecraft T1 (Figure 8), but it would not load my wire on 160 and 80.

The Final eMylo Coupler

The entire coupler is built on a sheet of Plexiglas. The relays are mounted on the bottom of the Plexiglas. See Figure 9.

As shown on the schematic in Figure 10, I separated the RF ground and the DC ground with a small choke. Not sure if that was necessary.

How Does it Work?

Absolutely fabulous! The performance is dependent on how fastidious one is in the final adjustments. This was a great place to use the nanoVNA. Compressing or spreading the turns on the toroids yielded a worse-case SWR of 1.2:1 on all the bands of interest.

It is possible to screw things up by activating more than one relay. The #4 position, for example, is my 40 meter LC combination. A button press on the hand-held TX activates that matching network. A second button press deactivates that band. It's also possible to simply kill power to the bias-tee. This removes DC power to the remote coupler and re-sets all receivers to zero.

Speaking of the bias-tee, the diagram is in Figure 11.

The "B-word"

So disgusted by every antenna discussion devolving into endless yammering about Baluns. I coined the term "No-UN

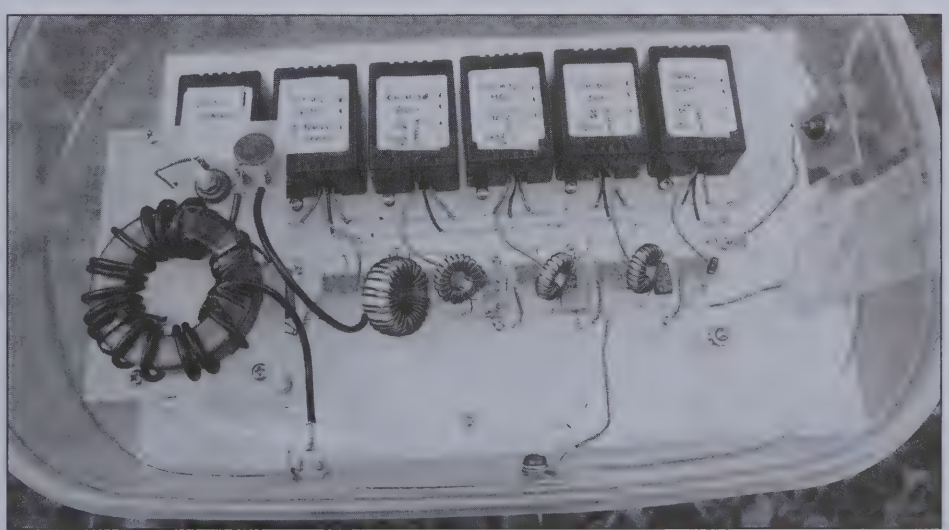


Figure 9—The final eMylo based tuner system.

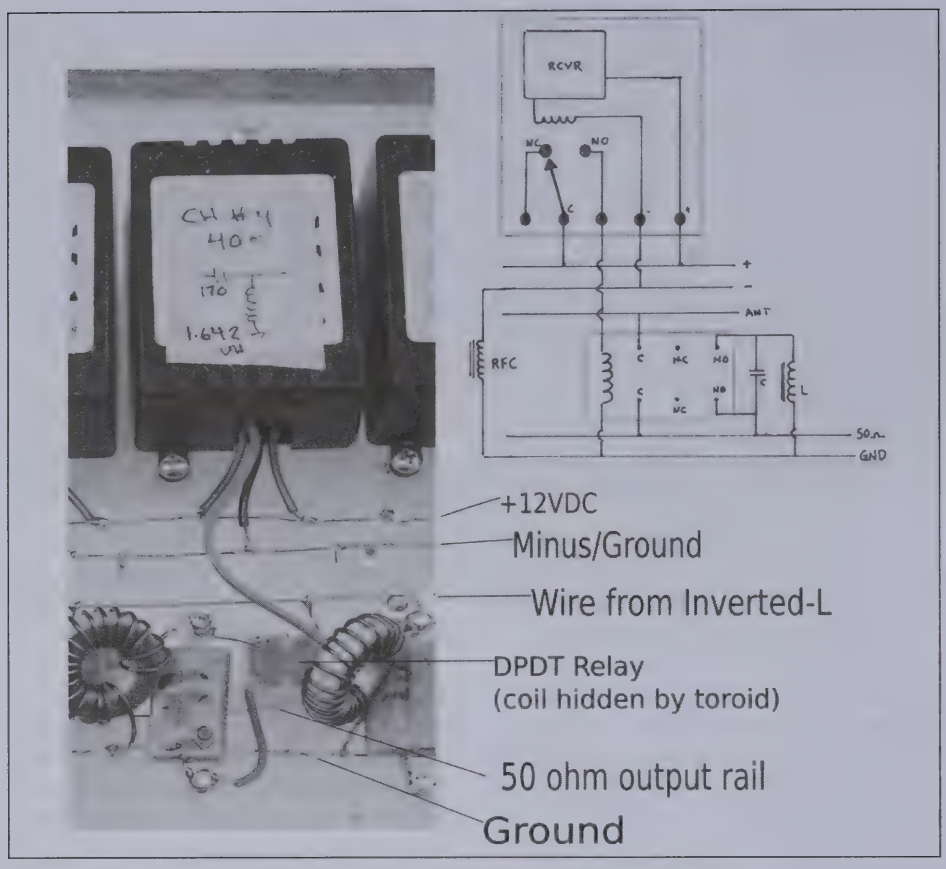


Figure 10—Close-up photo and diagram of a matching section.

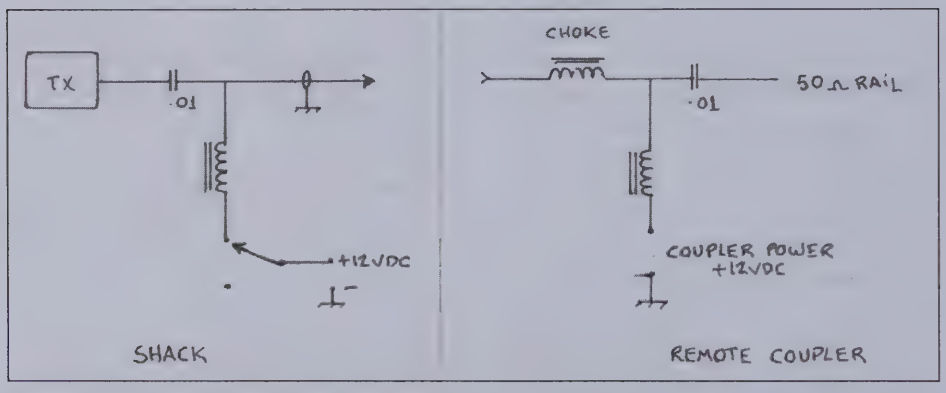


Figure 11—Schematic of the bias tees.

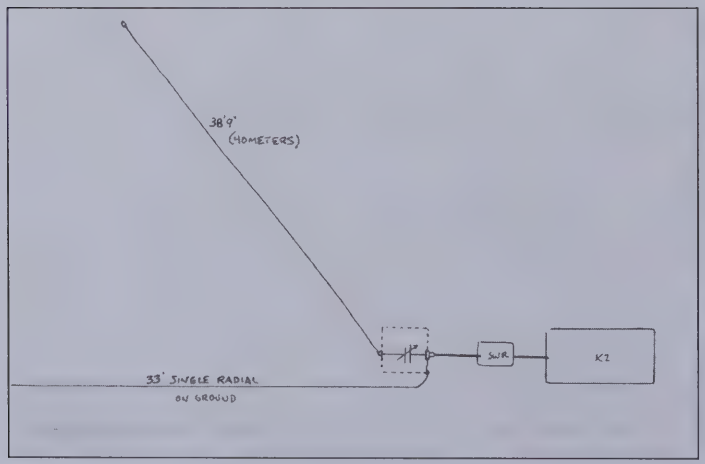


Figure 12—My No-UN antenna.

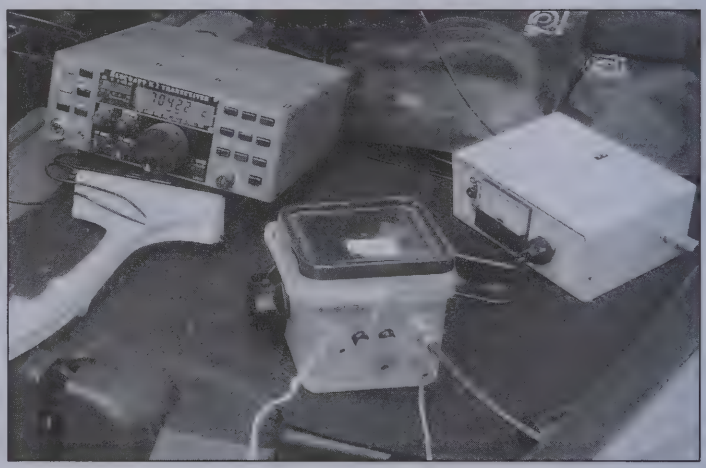


Figure 13—Test setup for the No Balun antenna.

Antenna"—that is, an antenna that does not employ a Balun. The reader of this article should refer back to the beginning charts—there is no reason why the charts can't be used to make an antenna for any band. I built a "No-UN' for 40 meters:

Neat antenna. Yeah, but if you want to use it on other bands, a different matching network will be needed.

My smugness about making a Balun-free antenna was diminished by somebody on the QRP-Tech forum suggesting a common-mode choke might not be a bad accessory to install in the coax feed. Darn! It's an excellent suggestion. I have a common-mode choke on the remotely switched coupler described in this paper. My "No-UN" test set-up can be seen in Figure 13.

Conclusion:

These little eMylo wireless receivers and transmitters can be used for a variety of applications. The TX has no problem "talking" to the remote receiver(s) about 100' away, through a wall and a stack of intervening ham radio gear. This paper was not intended to be an exact "how-to" article, but there is enough material here to allow for the intermediate builder to make his/her own remotely switched coupler. The most valuable piece of equipment was my AADE LC meter. I think there are comparable LC meters out in the ham universe.

And of course, the ultimate disclaimer, "your mileage may vary".

—73, Jerry KI4IO

●●

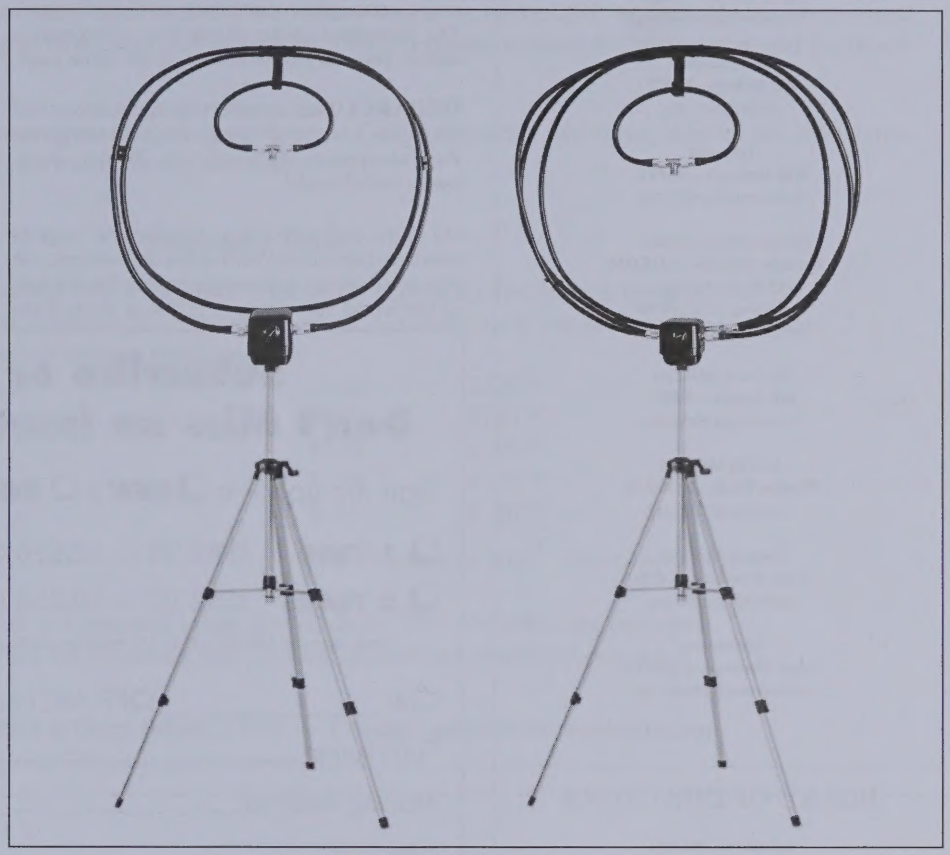
ICOM AL-705 Correction

Corrections to the article "Getting Ready for the ICOM 705,"

The ICOM AL-705 Magnetic Loop manufactured by Alpha Antenna®, had not yet been made available to anyone at the time it was discussed (reviewed) in the article "Getting ready for the Icom 705", Volume 61 Number 4, October 2020 issue of *QRP Quarterly*. The price in the article was incorrect, as the MSRP of the ICOM AL-705 magnetic loop is $299 and not $400. Extra efficiency was also not addressed in the article, as the ICOM AL-705 can be made to have more efficiency on 20 to 40 meters and add 80 meters, by adding the AL-705 Enhancement Kit. Specifically, the optionally available AL-705 Enhancement Kit comes with everything necessary to add 60 and 80 Meters, as well as increase efficiency on 20 to 40 meters. It also comes with everything necessary to deploy the ICOM AL-705 magnetic loop on an included tripod or hang it from an included carabiner.

We look forward to reader feedback once the ICOM AL-705 antenna is released for purchase.

—John VE3IPS



The AL-705 Enhancement Kit provides a tripod for easier deployment, and improved efficiency. Two concentric loops increases efficiency on 20 to 40 meters. Three concentric loops enables 40/60/80 meters.

References

https://www.icomamerica.com/en/products/amateur/handheld/705/al-705.aspx

ICOM AL-705 Antenna

The Icom AL-705 magnetic loop antenna from Alpha Antenna® operates on the 40 meter to 10 meter amateur bands. Maximum power is 20 Watts SSB, 10 Watts CW & Digital. The deployed diameter is 26.5 inches, which breaks down for storage in the lower compartment of the optional LC-192 backpack. Antenna comes with 15 feet of feedline with a BNC on one end and PL-259 on the other.

AL-705 Enhancement Kit

The AL-705 Enhancement Kit for the ICOM IC-705 radio's magnetic loop antenna will:

- Add 60 & 80 Meters to your ICOM AL-705 magnetic loop
- Increase efficiency on 20 to 40 Meters
- Provide a tripod for easier deployment
- For a limited time only, a carabiner for hanging the loop
- Power ratings with the Booster Cable are 10 watts on PEP SSB, CW, AM, FM, and Digital modes.

Included items are: Carabiner with D-Ring – Tripod Adapter – Tripod – Tuned Spacer – Booster Cable – Barrel Connector – 8 Nylon Coax Clips.

●●

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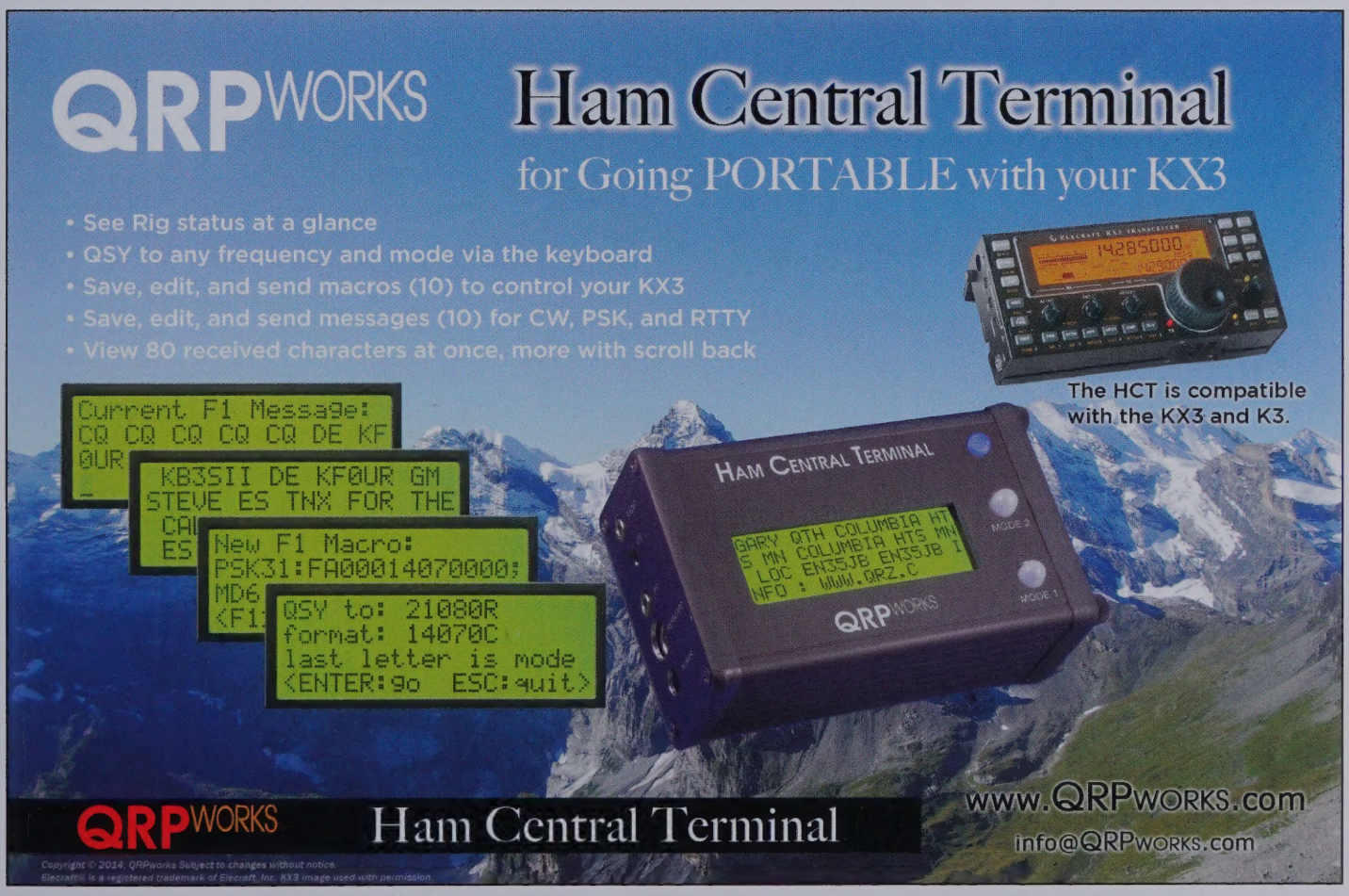
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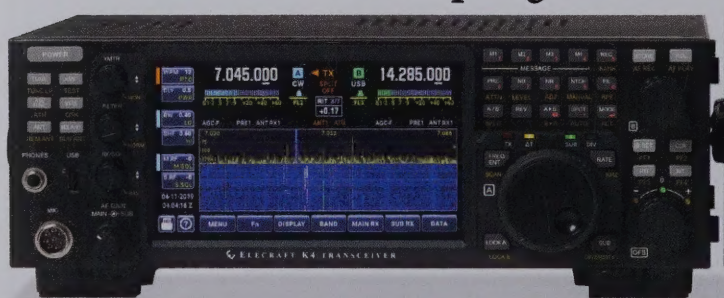

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